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# DISCOVERY

## A Monthly Popular Journal of Knowledge

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*AUSTRALOPITHECUS AFRICANUS*
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## Editorial Notes.

HUMAN and anthropoid fossils have been discovered at a fairly rapid rate during the last quarter of a century. The latest is the "Australopithecus Africanus" skull from the Taungs quarries. Its importance has been rather generally recognized by the lay public as well as anthropologists, and this interest shows a curious general acceptance of the evolutionary theory as we hold it to-day rather than as it was held by our grandfathers. What a fuss this fossil would have caused when the Darwinian controversy was at its height. Both sides would probably have come to quite wrong conclusions about it—but what a fuss there would have been. The old bitterness which characterized the controversy between the original evolutionists and those who insisted on a literal acceptance of the Biblical tradition still endures in some of the backwaters of America. Only last year a number of school overseers guilty of believing in the evolutionary theory of the development of man were discharged from their posts. An unavailing protest was made on behalf of the victims. The public, however, preferred the more flattering account given in Genesis to anything the professors could bring forward. It is probable that the discovery of a genuine "hundred-per-cent American" fossil skull is the only thing which will convert them. There should be plenty of fossil skulls there.

* * * * *

The new Wireless Bill promoted by the Postmaster General is a discreditable affair. In case of national emergency all these powers can be granted under an Order in Council or a new D.O.R.A. To vest such rights of search, entry and interference with scientific experiment in peace-time in the hands of the Post Office is both undesirable and ridiculous. Wireless has a very dubious political history, and the close association of great commercial enterprises and the Post Office is not an alliance which inspires public confidence. The new bill if passed without amendment would permit a very wide range of official interference with electrical experimental work of all kinds, and it is doubtful if the Official Secrets Act which should safeguard any necessary disclosures made to the officials from further disclosure is sufficient to soothe a naturally suspicious inventor. He will probably try to evade what he considers an unjust law. The trouble is further accentuated by the demand of the Postmaster General to make regulations at his discretion in place of following the usual procedure of discussion in the House and obtaining Parliamentary sanction. Scientific experiment in general is affected. In a word, not only wireless in the ordinary sense of signals or telephony, but the use of etheric waves for other purposes than signalling are to be under the supervision and regulation of the Post Office. All kinds of research work may be illegal. Myriad forms to be filled up may descend on our laboratories. A new cohort of paid inspectors must be raised and all sorts of salary-raising development to be paid for by the overburdened taxpayer would be necessary to give effect to the new regulations. It is not good enough. The restoration of the penny post and the improvement of our not too up-to-date telephone services are two far better subjects for the Postmaster General to concentrate on. As for the matter of the evasion of licences, this can probably be dealt with efficiently without the abuse of fundamental principles of liberty suggested in this savage bill. Motor-car licences, dog licences, and gun licences are all necessary evils and not subject to wholesale evasion. In the old days of motoring local authorities used to make a handsome profit on

people who broke the speed limit. There is little doubt that even without the right of entry and search, action by the local authorities would bring in the majority of the "pirates." The new bill requires very serious consideration and wide amendment. As it stands it is an attempt on the part of a department to obtain excessive powers which may and probably will be unintelligently applied to the restriction of progressive science in the interests of established commercial activities.

* * * * *

It is curious that despite all education few of us realize that this century is going to be remarkable not so much for loading the ether with the echoes of the music hall as for our development of the resources of the tropics. We do not yet realize how the tropics enter into our normal daily life, yet we depend on them from the morning cup of tea and sugar and the cotton in the clothes we wear, down to the rubber in the taxi tyres that brings us back from a theatre last thing at night. And we are only just beginning to think of developing them on sound scientific lines. In the past our young men were sent out in a casual kind of way to "tea-planting" or "rubber" or to a plantation of some kind. The story of tropical agriculture as often told by the survivors was that you cleared bush, fought fever, and eventually just as the proposition was about to pay a new kind of disease, pest, or bug appeared and ate up the plants. Successful tropical farming was only attained after costly and disheartening experiment and endless hazard. It is to put an end to this chaotic and unscientific waste of time and money that the Imperial College of Tropical Agriculture (London Office, 14, Trinity Square) has been founded, and is appealing for £100,000. The college has been started in Trinidad in the West Indies and is already a going concern. It will provide a practical training centre for young men who will later go to the vast areas of undeveloped tropical land we possess in the Empire and proceed to grow food or clothing materials for us. Tropical agriculture is a very different career to-day if we compare it with conditions twenty-five years ago. In those days the tropics were fever-stricken. To-day science is in a fair way to make them as healthy as the temperate zone. Plant diseases have been investigated and in many cases conquered. New and improved strains of plants with natural resistance to blights have been brought out. Fruits have been developed into varieties which will bear long sea voyages, new markets have been developed. The pioneers' work has been done. Every year the demand for food and materials grown in the tropics becomes greater, and we are about to see the productive development of great lands which are still to most of us but names upon a map. When we took them they were but wastes inhabited by savages. To-day the knowledge we have acquired renders them useful and valuable not only to ourselves but to the world at large.

* * * * *

The use of an international language for science is again being canvassed, although the adoption of English by the Far Eastern nations goes far to simplify the matter. The objection to the use of English for scientific writings, by foreign nationals and orientals in particular, is largely because of our preference for Greek and jargon. The intelligent easterner objects to having to learn Greek as well as English, but does not seemingly find the same difficulty in regard to Latin. The Latin on the other hand objects with equal vehemence to English, German, and invented languages like Ido, Esperanto and official Irish. The most controversial solution seems to have been put forward by Mr. Heron-Allen in a recent issue of *Nature*. He suggests dog-Latin, the casual conversational bad-Latin of the Catholic Church instead of the pure and not easily understood classical brand. There is a good deal in the suggestion, for though the average man may not be able to follow a Latin play even in the purest Westminster accent, he will probably understand a good deal of the epilogue which is usually a topical revue in less refined Latin. Dog-Latin certainly can be used to bridge many gulfs, but it may perhaps not lend itself to the needs of the day. What is wanted is a descriptive word or a practical abbreviation. Nothing could distress a philologist more than the "foreign cable" desk of a newspaper office where abbreviation saves a dollar a word. It is these unknown arbiters who have given us taxi, tube, plane, and other words now enjoying international usage. This trick of simplification might be copied with advantage by scientific writers. We know that it can be done because the real leaders and thinkers in the scientific world to-day all write clearly and plainly in simple English. A mass of polysyllabic jargon is, on the other hand, nearly always the sign of an inferior class of brain.

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A CATALOGUE of publishers' remainders is always worth perusal. On glancing through the list issued by Henry W. Glover, 114 Leadenhall Street, London, E.C.3, we notice some very useful volumes, particularly those relating to science, philosophy and natural history, in addition to works of reference and others of a miscellaneous character.

# The Language of the Bees.

**By Charlotte Burghes.**

*The story of the marvellous discoveries of a German scientist, telling how the bees transmit intelligence of their discoveries to their fellows in the hive. The writer reveals some of the most fascinating secrets of insect life—the Honey Dance, the Pollen Dance and the Scent Signal.*

THE greatest mystery of the hive—the problem of how, if at all, the bees communicate with one another—has been solved at last. It is probably the most romantic story of entomology. The life of the honey-bee has always had a strong interest for the human mind; scholars, scientists and poets have contributed to the vast literature on the subject. But hitherto the problem of the methods of communication of the apiary has baffled the ingenuity and the patience of human investigators. Its solution is the achievement of a German, Herr en Karl von Frisch, and the story of his experiments and researches, published in *Die Naturwissenschaften* for November, will arouse the most intense discussion throughout the world.

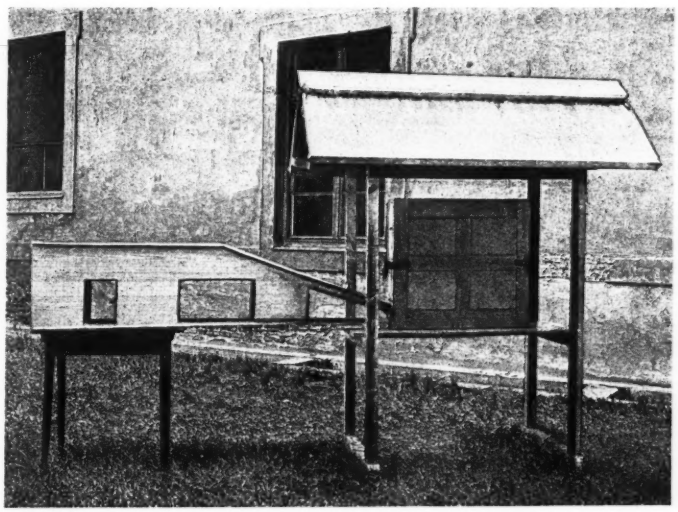


FIG. 1.
EXPERIMENTAL OBSERVATION HIVE WITH PROTECTIVE ROOF AND GLASS PANES.

It was found by Herr von Frisch and other workers that a given bee will as a rule frequent one, and only one, kind of flower. Again and again she will return to the blooms of a certain species, ignoring the efforts to attract her of all others. What is the cause of this singular devotion? Bees can see—and what and how much they see is in itself a marvellous story—but their colour sense is not sufficiently developed to supply an entirely adequate explanation. They have, however, a sense of smell which is quite as intense as our own, and their memory for smells is one of their strongest characteristics. They can recognize a scent at just about the same degree of dilution as a human being, and the perfumes of certain plants to which the human nose is not sensitive are quite accessible to them. Herr von Frisch proved experimentally that the bee's smell organs were in its antennae, for if these were cut off it could still distinguish flowers by their colours, but not by their scents.

The flower perfume appears not to be a device for attracting the insect, but one which provides it with a means of discrimination between the blossoms of various species. But, as we shall see later, the bee's power over smell, in addition to this function, plays an enormously important rôle in the hive. It is, in fact, one of the two means of communication at present known to us.

Herr von Frisch began his experiments by putting small pieces of paper smeared with honey on garden tables. It was sometimes necessary to wait for hours, even days, for a bee to discover the new store of nectar. But when one had done so only a few minutes passed before hundreds of others, all from the same hive, arrived to lap up the new supply. How had they been told the news of the discovery of the treasure? How were they able to find their way to it?

In order to answer these questions, the investigator constructed a special observation hive. The combs were arranged in flat superimposed tiers one above the other. They were covered with protecting sheets of glass, and apparently the bees soon got accustomed to the light. As the hive contained between 30,000 and 50,000 inmates, it was necessary to find some way to distinguish a few of them from the others. Herr von Frisch found a means of marking 599 of them with five different unwashable colours and he became

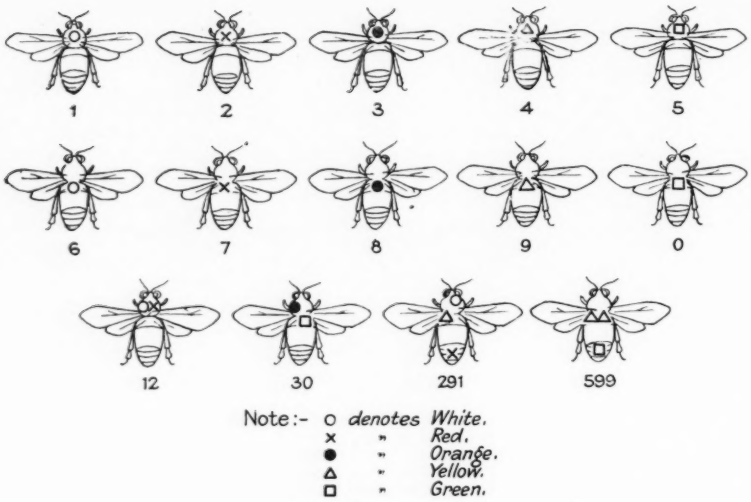



FIG. 2.
SYSTEM OF MARKING BY MEANS OF WHICH 509 BEES COULD BE DISTINGUISHED AMONG THOUSANDS OF THEIR SISTERS.

so expert in his observations that he could, so he tells us, distinguish his marked bees even when they were in flight.

It is as well to point out, before continuing the story, that the experiments described here were carried out during many long years, or otherwise their results might seem too miraculous to be believed. The evidence accumulated gradually, and was tested again and again by repetition until it seemed unshakable.

The observer followed the subsequent actions of one bee who had filled her little crop with as much of the honey or sugar-water from the newly-discovered store as it could hold. As soon as she is replete, she flies straight back to the hive, and begins to distribute the food to other workers who meet her and who, after sipping a certain amount themselves, carry it to those places where it is most wanted. The honey gatherer never, apparently, performs this work herself.

### The Honey Dance.

But she does something far more remarkable. She begins to dance. If the reader has ever seen or heard of the old Cornish " Floral Dance " he will be able to visualize more easily the behaviour of the bees. In this dance the people join hands, forming a chain that whirls through the streets, in and out of the houses, apparently aimlessly, for a long time. Our bee begins a similar performance on the combs. In a state of intense excitement she starts moving round in a circle with quick, tripping little steps. After a time she suddenly turns in the opposite direction and repeats her movements. She carries out this dance from three to twenty times in the same place. She then stops abruptly, rushes to the door of the hive, and flies back as fast as her wings will carry her to her new feeding-place. But in the meantime her conduct has created a tremendous stir. She has begun her performance in the middle of a dense crowd of her fellows, bumping into them in the course of her gyrations. These turn their heads towards her to see what is happening and, as soon as their attention is attracted, also evince signs of intense excitement. They endeavour to hold their feelers against her abdomen, and as one joins the other, the first bee, just like the first dancer in " Follow-my-leader," gathers a tail of others behind her. From time to time one of these will drop out of the throng, dash to the hive door and fly off. In due course those who do this return and follow the example of the first explorer, starting dancing chains of their own.

### How the News Flies.

What precisely has happened? How has the dance conveyed to those who took part in it the location of the new store? And how do they manage to find it, going off as they do in the middle of the performance? They do not follow the original dancer when she goes off again, nor lie in wait for her at the hive door, but precede her to the new honey store. Does she manage to convey to them by a secret sign the direction and the distance from the hive of the food?

In order to ascertain what had happened, Herr von Frisch placed at a distance of fifteen yards to the west of the hive a watch-glass full of honey on which his marked bees had been fed. He put others at greater or lesser distances in all directions. Every glass in the neighbour-

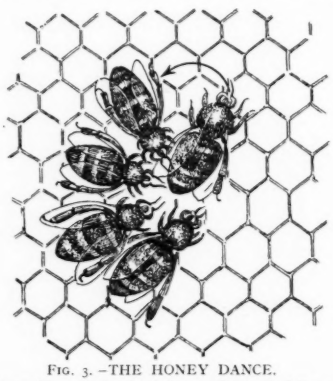


FIG. 3.—THE HONEY DANCE.
Returned bee moving in circles on the comb, followed by others who endeavour to establish contact with her.

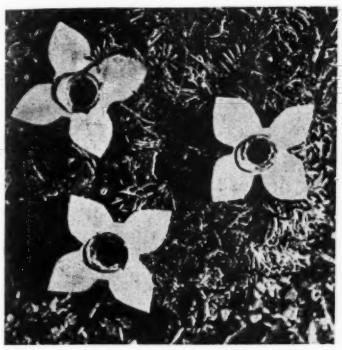


FIG. 4.
FEEDING OF TRAINED BEES
by means of artificial blue flowers, fastened to a small dish covered with moss.

hood was flown to by new bees within the very shortest time of the feeding, return, and dancing of the marked ones. If the bees had not been fed, and no dance had occurred, the provisions remained undiscovered for hours, and even for days. Distance had no effect on the experiment. In one case a store was placed in a meadow a full kilometre from the hive, with hills and woods lying between them. After a wait of four hours the bees found that one too. As soon as they had begun to sip the honey they were marked, and their progress home was signalled by a specially-placed chain of observers.

Now, after the dance had taken place, the new explorers set out to seek the treasure. First of all they searched everywhere in the vicinity of their home, and as they found nothing, they gradually extended the distance of their flight until they had covered the whole area as far as the meadow where their perseverance was rewarded.

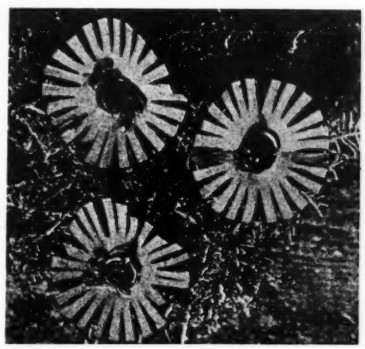


FIG. 5.
ARTIFICIAL FLOWERS
of different shape and colour to those in Fig. 4.

### Changed Flowers.

In the next experiment, the watch-glasses were replaced with real flowers, cyclamen blossoms, filled with a few drops of sugar and water. The result was identical, but it had an interesting sequel. When the cyclamen flowers were provided, but minus the food store, they were still visited, and if they were placed next to blooms of phlox, which also contained nothing, the phlox were ignored while the cyclamen flowers were searched again and again with patient obstinacy. If the flowers were changed round, the bees would visit the phlox and ignore the cyclamen. Clear evidence was thus obtained that the bees could discriminate between the scents of various flowers, and that by means of the dance they could tell each other which kind of flower to look for. Therefore, if a new store of nectar was "said" to be found in a cyclamen cup, all cyclamens, but only cyclamens, would be visited, until the one containing it was reached.

Artificial flowers, containing a drop of an ethereal oil like peppermint, could draw them too, and after having visited one of these they would show the greatest interest in anything in the vicinity of the hive which smelt of peppermint.

### Discriminatory Powers.

It is obvious that something of the scent of the flower clings to the bee, and that the dance is the means which enables her to communicate this scent to the largest numbers of her fellow creatures.

The benefit to the plants is naturally of inestimable importance. For this behaviour on the part of the bee makes it certain that when the flowers of a new species are discovered, others of the same kind will be eagerly sought for, and so their fertilization will be ensured.

Careful observation revealed a further important point. The numbers of collecting bees appeared always to be in reasonable proportions to the amount of food available. It seemed as if in this matter also an understanding had been reached among them. In order to ascertain what took place in this connexion, a new experiment was made. A poor honey harvest was initiated by substituting for the watch-glass shells blotting paper moistened with sugar-water. The bees came and fed on this also, but they had hard work to fill their pouches, and when they returned to the hive they did not dance. In consequence no newcomers arrived to sample the blotting-paper meal. The same held good when artificial flowers which had only been provided with small stores of food were substituted for it.

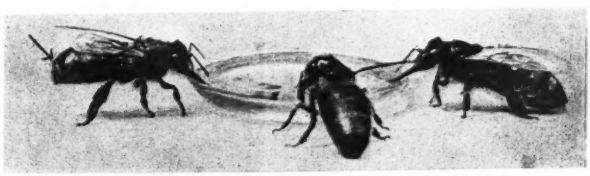


FIG. 6.
FEEDING BEES.
The arrow indicates the special scent organ which is being protruded by the bee on the left.

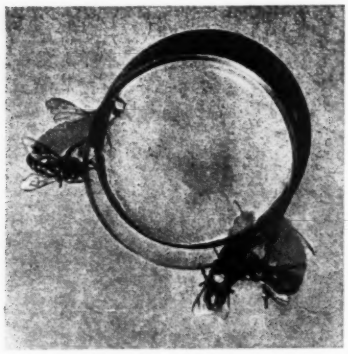


FIG. 7.
BEES AT THEIR ARTIFICIAL FEEDING-PLACE—a watch-glass filled with sugar-water.

Two places equidistant from the hive, but in opposite directions, were chosen for the next venture. At one the marked bees found an abundance of honey, at the other only a small amount was provided. No artificial scent was provided in order to attract them. Nevertheless, the bees who had found the rich store danced as usual, while their less fortunate sisters did not, with the result that ten times as many new seekers accumulated where the honey flowed generously as visited the spot where it was hard to obtain. Careful investigation at last led the observers to understand how the bees signalled their discovery of the plentiful, though odourless, stock. The well-fed bees, as they flew or sipped, pushed out a small organ of their own which serves them as a miniature scent factory, located in a pocket of skin containing glands at the end of the abdomen. By means of this they can produce a strong, fruity scent which is discernible by the human nose, but which was found to have an enormously strong power of attraction for other bees, even at a great distance. It was this smell which drew new fliers over a considerable area to the abundant honey harvest, even when the cup or flower containing it was scentless.

### The Pollen Trot.

The pollen-gathering bees are never the same ones which collect honey. But they also have their dance, which is so distinct from the "honey-trot" that a trained observer can discriminate between the two at first sight. Its special characteristic is a kind of "tail-wagging" movement of the dancer, by means of which she rubs her little pollen baskets on the faces of the interested onlookers, and particularly on their outstretched feelers. The pollen of each flower has its peculiar smell, which is often quite a different perfume from that of its petals, and it is this pollen scent, when spread by means of the bee's movements, which carries the news to her comrades.

Two groups of pollen bees were marked, one of which comprised rose visitors and the other addicts to Canterbury bells. The flowers of these two species were deprived of their pollen, so that after a while they were searched by isolated gatherers only. The anthers of certain Canterbury bells were taken out, and were replaced by the anthers of roses, which were fastened inside the flower by tiny needles. In due course a bee visits a Canterbury bell, and flies back to the hive with a rich harvest of *rose* pollen. And now a most curious thing happens. Dance as she will, she is quite unable to attract the attention of her Canterbury bell pollen-gathering companions. She is no longer one of them. But, if she feels any disappointment at this unusual result, it is soon mitigated by the delight shown by the rose-pollen collectors. These crowd around her, and soon fly off to confirm the news she brings in their own persons. But now it is their turn to be perplexed. For, naturally, they fly to the roses and, finding no pollen or only minute traces there (as it has been carefully removed in anticipation of some such behaviour on their part), they spend a long time patiently seeking it in vain.

(*Concluded on page 87.*)

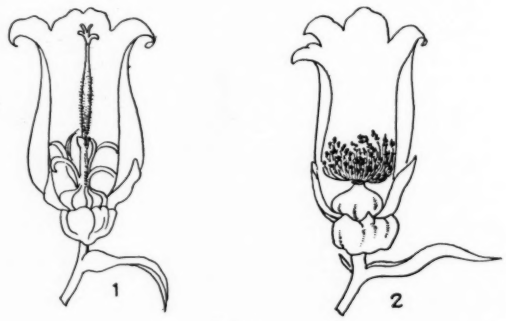
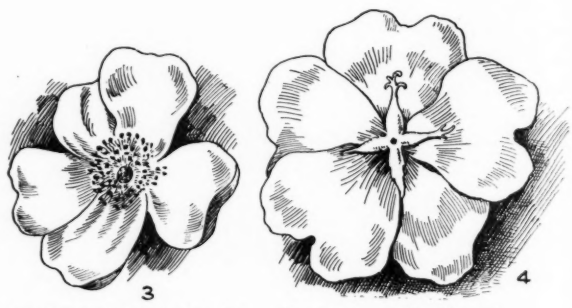



FIG. 8.
BLOSSOM OF CAMPANULA MEDIUM with part of petal removed to show the inner arrangement.

The same, into which stamens of Rosa Moschata have been fixed.




BLOSSOM OF ROSA MOSCHATA.

The same as 3, with pollen and stamens of 1 affixed instead of its own.

# Historical Microscopes.

*The early instruments used in any branch of science are of increasing interest and value. The curious old microscopes of two centuries ago bear little outward resemblance to our working tools of to-day, but it is from them that our modern instruments of precision have been developed.*

THIS month has seen the disposal of the last section of the late Sir Frank Crisp's collection of microscopes, those dating from the early seventeenth century

EARLY ENGLISH MICROSCOPE BY T. MARSHALL.
(About 1704).

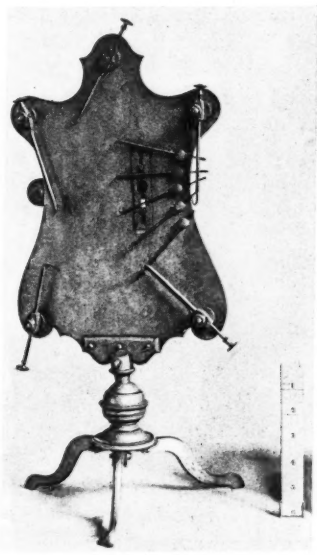
to the early nineteenth century of the period before achromatism had been conquered.

They were sold at Stevens' Auction Rooms on Tuesday, 17th February, to as distinguished a ring of purchasers as ever attended an important scientific sale, for Stevens' is to science what Christie's is to art. As is inevitable with any personal collection, the dispersal means a redistribution into the hands of individuals; but it is to be hoped, so far as the individual purchasers are concerned, that they will in their turn bequeath their specimens to the Royal Microscopical Society who are slowly gathering a representative collection illustrating the development of the instrument.

### An Age of Lenses.

The auction catalogue was admirably compiled, but necessarily the brief limit of space gives little opportunity to describe a marshalled sequence of development covering some four hundred instruments. There is at present no history of the microscope, but one is being written and the first volume will probably be published in the autumn by the Royal Microscopical Society.

Seen before the sale in the trestled store-room the microscopes presented a bewildering array, a confusion that the mind could not grasp—four hundred old microscopes, the youngest almost a century old. Many were unimportant variations, but the best pieces were wonderful, for they all belonged to an age when the craftsman put something of that nebulous quality we call art into his work. They could, I suppose, have made their barrels of polished brass, but they preferred stamped leather or shagreen as a covering. They fretted their brass into pleasing pierced scroll work, chased and engraved their silver, and had a thousand pleasant little indulgences which did not deteriorate the practicability of their instruments. One may be conscious of the beauty of a modern microscope as a supremely efficient scientific



DISSECTING MICROSCOPE ON LIEBERKUHN'S MODEL.
(About 1750).
The hooks hold the object.

BOX MICROSCOPE OF ABOUT 1740, WHICH BELONGED TO POPE BENEDICT XIV.

instrument—but one cannot but regret the passing of the little touch of individual art the old tools bore.

One of the most important pieces from the collector's point of view was Musschenbroek's simple hand microscope (1702, first form, in original leather case; very scarce, only a few being now in existence), a curious little affair with complex universal joints. It may have been used by some early member of the Royal Society in the days of William and Mary as a waistcoat-pocket piece with which to study the wonders of Nature. It fetched £5.

### Compound Microscopes.

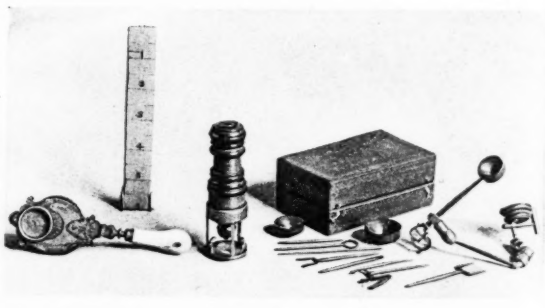
The Depovilly microscope is rather earlier and was more for the purpose of examining the objects provided in the disc-carrier which forms part of the instrument. Here is the description:—A beautifully engraved (on back and front) brass seventeenth-century hand microscope, after the form of that made by Cosmus Conradus Cuno of Augsburg, *circa* 1686; it consists of two plates, connected at the bottom by a hinge, below which is fixed the turned ivory handle; in the front plate, near the top, and in the centre, the lens, which is of very high magnifying power, is placed in a circular fitting; immediately behind this is fixed a brass wheel, containing eight objects, which can be rotated; the focussing is effected by a milled edge wheel, which connects the back and front plates; on the back plate is a small aperture, to act as a diaphragm; there is an additional small plate bearing a less aperture, which can be used when required. This beautiful little instrument is signed "Depovilly à Paris"; the length of the instrument is 5½ in., and it is in a perfect state of preservation, optically and mechanically; extremely rare. It brought £32.

### Foreign Microscopes.

The compound microscope of about the same date finds its example in a beautiful little compound microscope made by the celebrated Italian optician Guiseppe Campani. The compound body is entirely of wood, screwing into a brass tripod base, with an interesting spring attachment to hold the slides; the focussing is effected by screwing the compound body into the top of the brass tripod, which bears the maker's signature—viz., "G. Campani," in Roman; the eye-lens is double convex, of about 1-in. focus; there is no field-lens; the objective lens is a double convex of about ⅜-in. focus; the distance between the eye-lens and the objective can be varied. This beautiful little microscope is very rare, only about a dozen examples being known; it is both optically and mechanically perfect. This piece brought £45.

A period of forty or so years brings us to the compound type of microscope mounted on a box. The particular specimen illustrated was the property of Pope Benedict XIV, who succeeded to the Pontificate A.D. 1740, and it is a tempting speculation for us to wonder whether anything seen through the instrument may have affected the attitude of religion to science in its time.

The beautifully made box base is elaborately



Left.—Hand microscope by Depovilly of Paris (*circa* 1686).
Centre.—Compound microscope by G. Campani (late seventeenth century).
Right—Musschenbroek's microscope (1704).

inlaid with designs in marquetry on all sides, the front panel having a decorated shield design surmounted by the triple mitre and cross-keys; the compound body is covered in delicate green shagreen, with wood and ivory mounts, the metal parts being gilt; it has an engraved arm to carry the condensing lens, and a beautifully-engraved scalloped rotating object-holder; the hand forceps are also engraved; the apparatus is contained in a drawer in the base. This instrument is in perfect condition, and complete. This piece brought £31.

A little later is the microscope of Lieberkuhn, one of the great names of early anatomy still honoured in microscopy. A fine example of the original form of dissecting microscope, devised by Lieberkuhn, and made by Mitsdörffer, of Berlin, *circa* 1750, it is fitted with a number of adjustable brass hooks to hold the object under examination, and is on a brass tripod stand with ball-and-socket movements. £12.

Among other items of interest was the working microscope of Professor Amici purchased by Sir Frank Crisp from the Professor's heirs.

It does not follow that because a microscope is old therefore it is valuable. Some index of the prevailing prices given is afforded by the following, and it must be remembered that these prices represent something of an advance on the prices which would be brought at a sale of a less famous collection or as individual specimens.

A modification of the Hooke microscope (about 1675), £160. Marshall's compound microscope (*c.* 1704), £17, £22, £14. Cuff type microscopes averaged £1 10s.; tripod microscopes from a guinea to two guineas. Early non-achromatic nineteenth-century microscopes, complete in cases, seldom brought as much as a guinea.

## NUTRITIVE VALUE OF SNAILS.

M. L. Leger, lecturing before the Academy of Science of Paris, showed the result of recent investigations on *Helix pomatia* the edible snail so popular in France. At the approach of the hibernation period 80% of the fat, the glyocogen and the reducing sugars are concentrated in the liver. As this liver is usually rejected when the animals are prepared for the table he urges that the snail, like the oyster, should be eaten without mutilation.

The original room at Heathfield Hall, Handsworth, where James Watt carried out his experiments on steam engines, is soon to be transferred, with its contents, and rebuilt as an exhibit in the Science Museum, South Kensington.

## HAVE YOU GOOD SIGHT? TRY THESE TESTS.

**By J. A. Lloyd, M.B.A.A.**

To test your sight on the stars is an interesting occupation on a clear winter's night. Many stars offer really fine tests for keenness of vision.

The Pleiades are a notable example. This celebrated group, which can be easily recognized by everyone, to ordinary sight appears to consist of six stars.

But persons gifted with good vision can see seven stars in the Pleiades. The seventh is very faint indeed and needs clear air as well as good eyesight to detect it.

Some people can see more than seven, possibly nine or ten. Miss Airy, a lady astronomer with exceptional sight, could see thirteen.

Then there is the star Epsilon Lyrae. This is a small star close to Vega, one of the brightest stars in the northern sky.

To average sight, Epsilon Lyrae appears a single star. But there are many people who can see it as a double star. The two components are very close, apparently almost touching each other. If you can divide this star there is not much wrong with your eyes.

Some claim to be able to see the crescent of Venus with the naked eye. This is very doubtful, and astronomers consider that such claimants are the victims of illusion. But a very small telescope or even an opera-glass will clearly show it.

The moons of Jupiter are also excellent tests for good eyesight. That they have been seen with the naked eye is certain. But it must be admitted they are beyond the reach of all but exceptional sight.

## A NEW BONE-BUILDER.

All bone-building medicines contain more or less calcium, and the calcium salts used have the disadvantage that they are extremely unpalatable, a disadvantage particularly annoying when administering them to delicate children who are always suspicious of foods with an unusual taste. A new salt, synthesized by Dr. Robert Colne, of Berlin, combines the calcium with a palatable acid—lactic acid found in milk—with the result that the medicine has high bone-building properties and is pleasant to take. This compound is now being manufactured on a large scale by German drug manufacturers. Trials in German hospitals have shown its efficacy in increasing the bone development of weakly children.

# A Central American Experiment in International Peace and Co-operation.

**By R. B. Mowat**

(*Fellow of Corpus Christi College, Oxford*).

*A mutual treaty between five Central American Republics is now an established fact. The signatory republics are, however, only bound not to make war between themselves and there is no restriction on the time-honoured custom of revolution.*

THE Central American Republics—Nicaragua, San Salvador, Guatemala, Honduras and Costa Rica—have attracted more attention from novelists than from historians and lawyers. Yet these lands are well worth the attention of serious students. Their geography is interesting—the volcanic mountains, the enormous lakes, the tropical forests. In no country can an observer better study the influence of climate upon character. Montesquieu would have found a fruitful field for observation if he had extended his studies to Central America.

### Latin America

The five republics would seem destined to form a federation. Their peoples are not dissimilar, being of Spanish or Indian or mixed stock. They are not divided from each other by obvious natural barriers, by impassable mountains or by large stretches of water. Several of the boundaries, in fact, are so vague as to be seriously in dispute. The republics had a common origin and a common history in the Spanish Empire. Their language is the same, their intellectual culture is very similar. Nevertheless, the modern history of the Central American Republics has been marked not merely by revolution within, but by many inter-state wars. In spite of this, however, the tendency towards union presses inevitably although slowly onward.

Like the other Spanish colonies on the mainland, the Central American colonies gained their independence in consequence of the weakening of the home government's power during and after the Napoleonic Wars. South of the Isthmus of Panama the authority of Spain declined less quickly than in the north. By the year 1821 all the Central American colonies had gained their independence. The tendency towards union at once asserted itself, and in 1823 they formed a Central American Federation. This union endured for only sixteen years. Since 1839 the republics have been entirely independent of each other, and some serious wars have occurred.

It was not until the twentieth century opened that the natural movement towards union again became marked. In 1907 a number of treaties were entered into, to ensure inter-state co-operation, and in particular a Central American Court of Justice was established. When, however, an important case was brought forward for the court to settle its award was disputed and rejected by the Republic of Nicaragua. Thus the system established in 1907 came to grief.

This failure in inter-state co-operation had serious consequences. Competition of armaments, even in the small degree of armament which prevails in Central America, caused a very heavy burden of expenditure in the modest budget of the republics. Political exiles from one state, in safety behind the frontier of another, plotted for their return by means of revolution and wars. Boundary disputes continued to poison the relations of neighbouring States.

To ease this difficult situation, another attempt was made at inter-state collaboration in the more liberal atmosphere that prevailed after the Great War. Early in 1923 a conference of Central American Republics and of the Government of the United States was held at Washington; and in February of that year a series of twelve treaties was signed which, taken together, form an impressive body of international legislation.

### Treaties Signed.

By the first treaty, concluded on 7th February, 1923, the governments of the five South American Republics bound themselves to live in harmony, and to decide any differences which might arise between them through an international Central American Tribunal.

The constitution of this tribunal was defined in a separate treaty. It consists of a panel of thirty judges or arbitrators, six being chosen by each of the five republics. Of each set of six judges, four are to be nationals of the republic which choses them, and two are to be taken from a list presented by the United States. To this tribunal the republics agree to refer every dispute whatsoever, except questions which involve their sovereign and independent existence.

An international court for the whole of Central America is a wonderful thing. It may be in the establishing of similar regional courts in other parts of the world that the greatest progress of international law will take place. A court for the whole world seems likely to be impossible for a good many years, but regional courts, each with jurisdiction over a well-defined geographical area of contiguous States, seem to be perfectly feasible. The States within the jurisdiction of such a regional court should be within the same natural area, should be similar in civilization, and should have common trading relations. Central America answers to these conditions perfectly. Similarly, the whole of South America might come to have such a court for settling South American inter-state problems; Western Europe might have its own court; so might the States which border on the Baltic.

The Central American States have gone further than establishing a regional tribunal of inter-state jurisdiction. They have taken additional steps to eliminate causes of war by certain ingenious stipulations. In the first place, they have agreed by treaty to consider any revolution or attempt at revolution in one State as a menace to the peace of the rest; and they bind themselves not to recognize any government which comes into power in any of the republics by means of a revolution or *coup d'état*. If a civil war occurs the other States are bound to remain absolutely neutral.

### Regional Free Trade.

The closer political and legal conditions in one State approximate to those in its neighbour's territory the more likely is it that amicable relations will be maintained. Accordingly, the Central American Republics have agreed to treat each other's citizens as if they were their own: "the nationals of one of the Contracting Parties, residing in the territory of any of the others, shall enjoy the same civil rights as are enjoyed by citizens of the respective country." Even merchant ships of one republic when in the seas, along the coasts or in the ports of one of the others, shall enjoy precisely the same rights as ships of that country.

The judicial authorities of any one republic shall put into effect, if requested to do so, the judicial commissions and warrants of any of the other republics.

Economic and intellectual co-operation are the great means by which nations are brought together. Therefore the South American Republics have further strengthened their inter-state organization by two treaties of the highest significance. The first of these, quite simply, declares that free trade shall exist between all five republics. The only exceptions to this rule are to be coffee and sugar, and any articles in which a government has a monopoly. Here again, the Central American States seem to have shown the way of commonsense. It is hopeless to try to have free trade over all the world; but regional free trade, between a group of States whose geographical and economic conditions are not dissimilar, is perfectly possible and has been already a great success in the Prussian Zollverein and in the United States of America.

Free trade in intellectual affairs is provided for in the Central American treaties by conventions for the practice of the liberal professions and for the exchange of students. Central Americans who have acquired a professional degree in any of the contracting republics are to have the right of practising their profession freely within the territory of the others. For assisting the exchange of students, each government agrees to place at the disposal of each of the others six scholarships in one or several of its institutions of higher education.

Thus the Central American Republics, without entering into a federal constitution, and retaining complete sovereignty and independence, have produced a system which should ensure the absence of wars within their total area. Free trade and intellectual co-operation will develop feelings of friendliness and of community of culture, while it will not sacrifice the motive-power which exists in the citizens of each republic owing to the possession of a separate national history and institutions.

## THE LANGUAGE OF THE BEES.

(*Continued from page 82.*)

Such is the brief outline of the story told by Herr von Frisch. It epitomizes many researches carried out for years with laborious perseverance, influenced, no doubt, equally by love of the wonderful little insects that were its subjects and the natural indefatigable curiosity of the scientist. It opens up new realms of speculation for the imaginative, for the facts so simply recorded contain the very stuff of wonder and romance.

## AEROPLANES TO KILL MOSQUITOES.

PARIS green, an arsenical colouring matter, in the form of a fine powder was sifted down from aeroplanes upon mosquito-bearing swamps in Louisiana. The experiments were regarded as highly successful, since the aeroplane could reach parts of the swamp that would have been inaccessible by any other means.

# Modes of Thought and Æsthetic Expression.

**By Edmund Dulac.**

*Authorities on ancient civilizations are fond of expressing opinions on the art of these periods, although profound scholarship is not necessarily accompanied by any expert knowledge or appreciation of art. Mr. Dulac is not only a great living artist, but he is a profound student of early art. His article is stimulatingly suggestive of a more modern interpretation of art and archaeology.*

To be able to remind the public at large that works of art are the most important means of tracing back the history of the human race is, for those interested in art or practising it, a cause of much pride and satisfaction. Unfortunately the task of recovering these milestones of the past has been, so far, very little more than the hobby of a few endowed with patience, money, and a fair amount of æsthetic sense, and while indulgence in this is encouraged by scholarly tutelage, the same severe and suspicious eye that meets the pioneer in the world of science is cast upon the man who digs the sands of the desert and the earth of ancient lands.

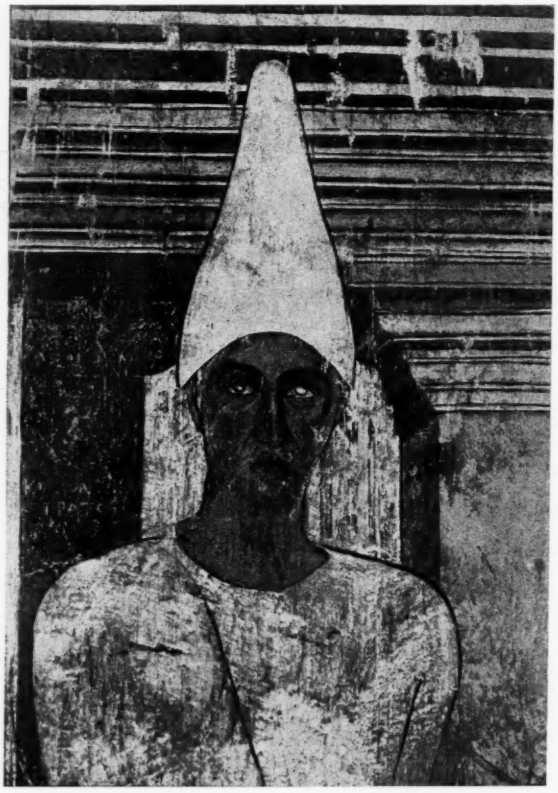


FIG. 1.—HEAD OF THE PRIEST (showing injury to left eye).
(From the wall decoration in Hall II at Dura).

### Tradition.

The results of his efforts must conform to the ponderous laws of accepted classification and respect the venerable decrepitude of traditional theories if they are to escape subsequent burial under the far more impenetrable dust of academic oblivion. Sometimes, however, rebellious discoveries come to light in such numbers and form such an imposing front, that theories take to their beds and laws have to yield. But they do so—it must be said—without grace, and not before having caused a precious measure of intellectual activity to be sacrificed to sovereign prejudices.

The discovered works of art do not always provide good material for the Press, nor do they always obtain a wide notoriety; in the majority of cases the general public is not able to pass upon them a proper judgment, either because it is not aware of their existence, or because all men in the mass are apt to follow the well-established prevalent opinions. Such will not, I hope, be the case with the remarkable discoveries made in Dura on the Euphrates at the north-eastern edge of the Syrian desert, by Mr. James Henry Breasted, head of the expedition sent by the Oriental Institute of Chicago under the auspices of the university of that town and described in his book, "Oriental Forerunners of Byzantine Painting." They provide a striking example of the art which those seated on the mighty heights of the "classical tradition" receive with an interest necessarily attenuated by their aloofness. This attitude, I should like to point out, is not explained by reasons sufficiently sound and logical to justify the impressive effect it produces on the man in the street.

The "classical tradition" is held to have been handed down to us by the Romans who had saved it from the ruins of Greece; it is supposed to have its origin in a period which is described as the "apotheosis of man"—to be more precise, of European man—the "Pheidian Age" and part of the hellenistic era. And when it is objected that this view—granted its accuracy—takes into consideration only one small side of Greek tradition, we are told that art, like

Sisyphus, is forever groping its way up the heights of absolute perfection—sometimes reaching the top but only to be cast down by the jealous gods and start once more on the uphill journey to another pinnacle of excellence.

Thus, since the first manifestations of man's æsthetic sense—that is to say, since the best part of perhaps 40,000 years—the classical purists recognize only two such zeniths of his endeavour—the traditional Greek age and its revival, the Renaissance. The purpose of art being "to express beauty and human nature" (whatever that may mean), the first is the glorification of beauty, serene and robust; as for human nature, it had to wait apparently until the middle of our fifteenth century to find adequate interpreters. By the side of these, Assyria and Egypt are stiff and conventional, Mycenae and Cnossos little more than chronological documents.

To those whose profession it is to teach art and history officially, to those whose outlook upon the world is of a simple kind, this point of view appeals very naturally, but its acceptance by the masses who "know nothing about art but know what they like" has been regrettable on account of its influence upon artistic thought in general and archaeology in particular; for to assign to the arts of the past, arbitrary or false values, is to mislead both art lover and historian. And, since it is obvious that the non-classical civilizations were built up by men who were certainly equal if not in some cases superior in sensitiveness, intelligence and culture to the fourth-century Greek, is it not more reasonable to admit that a psychological error has been made?—that the Greek legend is very thin, and that the art of thousands of years and of a hundred races points to the fact that the method of æsthetic expression has not one pure and ideal aspect, but two: one subjective, the other objective, which are the outcome of the two opposite modes of thought governing—besides other branches of human activity—every form of artistic manifestation and more especially painting.

### Subjective Art.

The subjective method is the more ancient, the more widespread and the most enduring, for its process is simple and rational. According to it, true representation is founded on our intimate knowledge of things, and independent of any point of view. The essential nature of the object is the thing that matters, accidents of light and shade, not being inherent in it, are left unheeded, for their shape and character do not change according to the time of day or the position from which we look at them. It is the same object whether the sun or moon cast a light or a shadow upon it, whether seen from above or from one side, and has no more value at one time than at another. The lights or shadows will therefore be entirely irrelevant factors that the mind does not naturally take into account; the pictorial representation of that object is meant to evoke in the mind of the onlooker not what the object means under certain transient conditions, but what it means at all times; it will consequently assume more or less the shape of a symbol, and any grouping of objects will follow the same principle.

### Illusion of Reality.

The artist is guided in his composition by the relative interest and importance of the things he has to depict—the greatest emphasis being laid on the most important. Thus in some Egyptian, oriental and mediaeval paintings, a king will be larger than his subjects, for relations of size and distance have no effect on the essential nature of men; relations of importance alone matter, and a king is considered of more consequence than his subjects; the artist disposes the elements of his picture to suit its meaning and bring out its real significance; he paints things not *as they happen to appear* but *as he knows them to be*. It is the art of the caveman, of Mycenae, Assyria, Egypt, and of all schools of oriental painting. Its process is rational and intrinsic. (Fig. 2, *a* and *b*). The second or objective method received definite shape and sanction a little more than four hundred years ago. Inspired by the life-like statues and paintings of the "realistic" school of ancient Greece, its aim is the faithful reproduction of the human body and the representation of natural objects as seen within the narrow field of one particular angle of vision. The artist is asked to display his powers of photographic accuracy and to leave nothing to the imagination of the onlooker. He is taught perspective and chiaroscuro in order that the illusion of reality should be as complete as possible; the relations between background and figures follow no longer the spontaneous rules dictated by the mind, but obey the laws imposed by an accidental point of view. It is the art of classical times, of the later Greco-Roman decorations and of most of Europe from the middle of the fifteenth century down to the present day. Its process is arbitrary and imitative. (Fig. 2, *c*).

The difference between the two methods is so essential that it is quite absurd to contend that the latter represents the final achievement of the long and painful attempts of the former. The work of, let us say, Raphael, is no more an improvement on Egyptian

is of a much later date, probably the third century; it is quite small and depicts the Roman tribune, Julius Terentius, with a priest and a number of officials offering sacrifice to three gods in Roman garb accompanied by two local goddesses and a few minor divinities. It is obviously the work of an inferior artist, judging by the sketch in Mr. Breasted's book, and therefore has only an historical value.

The first, however, interests artists and archaeologists in a supreme degree, and we must be doubly grateful to Mr. Breasted, for he has saved it twice: by discovering it in the first instance and then by giving us some photographs and a full account of it before it was hopelessly mutilated by desert Arabs. It takes a prominent place among what Mr. Breasted calls "the forerunners of Byzantine painting," and gives us hope that more examples of equal significance may yet be found to illustrate an advanced stage of what I have termed the intrinsic method at a period of which we know little outside the earlier Greco-Egyptian mummy-case portraits. (The almost contemporary Pompeian decorations are of the imitative type).

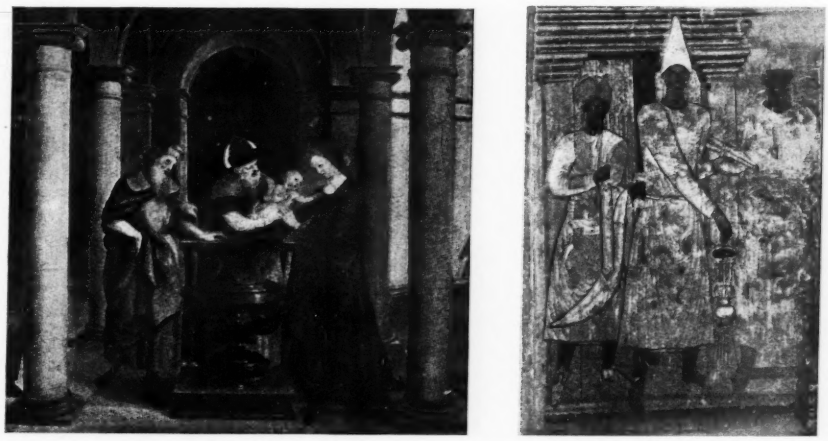


FIG. 3.—THE TWO MODES OF EXPRESSION DEALING WITH THE HUMAN FIGURE IN ANALOGOUS SURROUNDINGS.

(*a*) The Presentation in the Temple. (By Raphael).

(*b*) The wall decoration in Hall II at Dura. The priest and two ministrants.

### Likeness.

The picture is signed and the artist, Ilasamsos, an Oriental, gives us in it an excellent example of the subjective mode of expression. The figures have no "true to nature" relation to the background, and are painted without regard for the purely "photographic" incidence of light and shade. All the artist intended was to suggest likeness, gestures, draperies and location as they appeared to his mind, and regardless of accidental differentiation, thus instinctively practising that economy of means which gives simplicity so much force of appeal. I should like to choose this as an example to make clear the meaning of the preceding remarks. Take the figure of the priest: if the picture had been painted in the imitative style that is familiar to all, the artist, supposing the priest had sat for his portrait, would have faithfully copied what was in front of his eyes; all the shadows and high lights on the face and dress would have been carefully reproduced, and the result would have been a portrait of the man as he happened to be in that light at that particular moment. (Fig. 3, *a*).

Under the same circumstances, the artist with the subjective mentality used his model as a reference pure and simple. He noticed, for instance, that the lower part of the dress described a series of descending curves—all that mattered to him was that these constituted the inevitable characteristic of a drapery held by a belt (Fig. 3, *b*); also he was only interested in the particular angle of the features that made the face different from other faces, and that in whatever light the model happened to be, no matter how shadows were distributed, the features were those of the same man, the folds those of the same dress, and it was that man and that dress that he had to paint (Fig. 1). This process of elimination is not deliberate; we could quote cases of Orientals to whom shadows in a picture represent so many smudges that interfere with the real aspect of the objects.

### Absence of Perspective.

For similar reasons, perspective such as we understand it is not even thought of; the steps on which the figures are standing are, to the artist, primarily rectangular pieces of stone, the vase in which the priest is placing the flower an upright object with a circular mouth, and he paints them as, in fact, they are. The result has all the directness of power and simplicity of characterization that we find in the art of the Byzantine period, in the works of the early Sienese and Florentine masters, the portraits of China and Japan, and the productions of some of our modern artists.

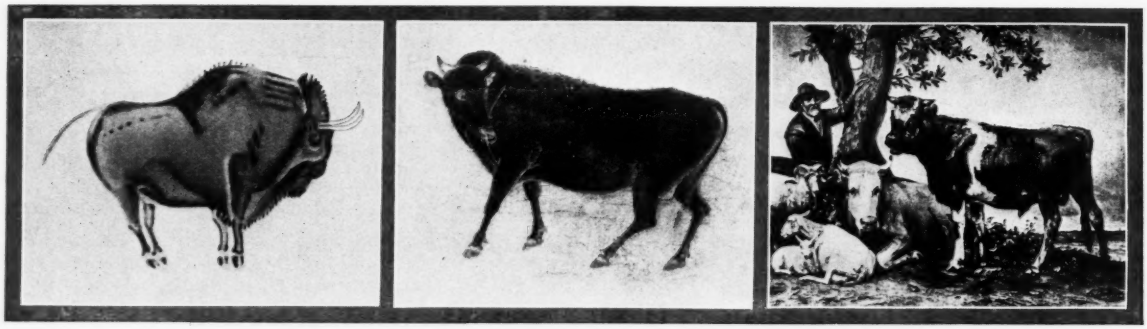


FIG. 2.

(*a*) A PREHISTORIC PAINTING OF A BISON. Cavern of Altamira, Spain. (?) B.C. 25000.

(*b*) YOUNG BULL. By Sanetada, Japan. XIVth century.

(*c*) YOUNG BULL. By Paul Potter. XVIIth century.

These three pictures show: (*a*) and (*b*) the results of a subjective process of expression; (*c*) an objective treatment of a similar subject.

painting than a giraffe is an improvement on a goat. The two methods have, on the contrary, coexisted side by side in relative proportion and have sometimes interpenetrated one another, but the subjective mode has never given way to the objective for more than a short period, and has always been practised in some form or other. It is clear that the two schools, which Pliny tells us existed in ancient Greece, can be taken as representing the two tendencies; an analogous situation can be found in modern Japan where painting in the traditional manner continues side by side with that inspired by European styles, or anywhere in Europe of the present day where attempts to turn the scale in favour of subjective art have succeeded one another with appropriate rapidity and a measure of success for the last twenty-five years.

### New View-point Needed.

What makes it difficult for people who have no inside knowledge of art to approach these subjects with an unbiased mind, is that questions of technique are the ultimate grounds of argument—formidable obstacles for a twentieth-century European to whom the mentality of his ancestors and that of non-European nations is generally a closed book. As an example bearing upon the special subject of these remarks—painting—it is impossible for him to realize that perspective was far more alien to the mind of the average artist of the ancient world than the Einstein theories are to the intellect of the average scientist of to-day. Still, if we reflect a moment, we cannot help realizing that the top, say, of a round table may appear to us, if we look at it from a certain level, to have the form of an ellipse. Yet we know this to be an illusion—the real table-top is circular and flat; therefore, if we paint it either as a circle or as a flat horizontal line, the unsophisticated spectator will recognize it for what it is. This is such a simple and rational conclusion that it took nearly one thousand years for perspective to destroy the natural inclinations of artist and public and become an established science. For we must not forget that the artist is first and foremost what Mr. Jung would call a "feeling introvert," meaning that his reactions to outside events and his interpretation of them will always be conditioned by the disposition of his feelings. His appreciation of the world being essentially subjective, it is as difficult for him to acquire perspective, chiaroscuro and most of the equipment of objective and imitative art as it is to acquire a language that is not one's own.

These academic points do not, in truth, disturb the immense majority of those who find pleasure in the products of both systems; they only affect those who, cursed with "a little knowledge," have no psychological understanding, judge of all arts by modern objective standards and fail to realize that, whatever their respective merits may be, each school possesses a definite and complete individuality, and that each fulfils its own purpose in the measure of greater or lesser intensity which we call beauty.

### Art and Archæology.

It is from that standpoint that we must approach Mr. Breasted's discoveries. They consist in two mural paintings found in a temple consecrated to Zeus-Baal. One, which is of the first century of our era and covers the whole wall, represents groups of figures in three superimposed rows: little remains of the top row; the middle one contains eight figures, all facing the spectator—a priest with two attendants, a lady of high rank, and four men; the lower register is occupied by two boys and a girl. They are apparently engaged in some form of ritual. The second picture

Apart from these qualities it is admirably suited to decoration, as it does not exceed the two-dimensional limitations imposed by the flatness of a wall. This is at once apparent when one compares with it the style of the figures and architecture in the frescoes of the imitative school at a correspondingly advanced stage—the beginning of the sixteenth century. Here the object of the artist is to deceive the eye and to make one believe that the level surface of walls and ceilings has been carved, corniced, pierced, lunetted, prolonged by colonnades and opened to the sky, to enable grave, biblical personages and athletic youths of both sexes to display their acrobatic ingenuity. He paints all these "in the round" in as convincing a manner as his knowledge and ability will allow him. But although the result appeals to a large number, there is nowadays a tendency on the part of people who have either escaped or outgrown the influence and teachings of the academy, to look upon these effects as being positively disturbing; indeed, while the considerable talent required to suggest depth and volume on a flat plane compels admiration, one cannot help feeling that from the technical point of view the ultimate and logical issue of objective imitative art is nothing less than coloured photography.

Space will not permit me to go further into details or to give a better description of the picture and the circumstances of its discovery. Interested readers will find this set out at length in Mr. Breasted's book, and I hope they will be many. I also trust that these remarks may help the uninitiated to understand more clearly that art forms are a reflection of the mental attitude, whether objective or subjective, of a period or of a nation, and that the difference between those two aspects is not a matter of degree but of essence, for each has its own method of expression, with its own rules, its own aims, and its own standard of perfection.

## THE BRITISH ASSOCIATION.

ARRANGEMENTS are in progress for the next annual meeting of the British Association, to be held in Southampton from 26th August to 2nd September, under the presidency of Dr. Horace Lamb, formerly Professor of Mathematics in the University of Manchester. Presidents of the several sections have been appointed as follows: Mathematics and Physics, Dr. G. C. Simpson, Director of the Meteorological Office; Chemistry, Dr. C. H. Desch, Professor of Metallurgy in the University of Sheffield; Geology, Professor W. A. Parks, of the University of Toronto; Zoology, Mr. C. Tate Regan, Keeper of Zoology in the British Museum (Natural History); Geography, Mr. A. R. Hinks, Secretary of the Royal Geographical Society; Economics, Miss Lynda Grier, Principal of Lady Margaret Hall, Oxford; Engineering, Sir Archibald Denny, Bart.; Anthropology, Dr. Thomas Ashby, Director of the British School at Rome; Physiology, Dr. A. V. Hill, Professor of Physiology in University College, London; Psychology, Dr. C. E. Spearman, Grote Professor of Philosophy of Mind, University of London; Botany, Professor J. Lloyd Williams, of University College, Aberystwyth; Education, Dr. W. W. Vaughan, Headmaster of Rugby; Agriculture, Dr. J. B. Orr, Head of the Rowett Research Institute, Aberdeen. Among principal items already set down for discussion are transport problems, to which the sections of Economics and Engineering will devote two days, with special reference to the railway centenary of the present year; the cost of farming and the marketing of agricultural produce (sections of Economics and Agriculture); the functional significance of size (Zoology and Physiology); the ignition of gases (Chemistry and Engineering); tidal lands (Geography and Botany); variations in gravitational force and direction (Physics and Geology); recent investigations upon vocational guidance (Psychology and Education); the distribution of animals and plants in relation to continental movements (Geology, Zoology and Geography); the acquisition of muscular skill (Physiology and Psychology); and discussions on health in schools, the disciplinary value of subjects, the training of teachers, and the teaching of biology.

Professor Parks, of Toronto, as president of the geological section, succeeds the late Dr. Willet G. Miller, the Ontario Government Mineralogist, who was to have occupied the chair of the section.

## ROYAL MICROSCOPICAL SOCIETY.

THE next meeting of the Industrial Applications Section will be held on Wednesday, 25th March, 1925, when Sir David Prain, C.M.G., F.R.S., will preside, and Professor Percy Groom, M.A., D.Sc., F.R.S., will read a communication: "The Microscopical Investigation of Fungal Attacks on Wood."

A communication on "The Application of Microscopy to the Photographic Industry," by Mr. A. P. H. Trevelli and Mr. R. P. Loveland, will also be read.

Dr. James A. Murray, M.D., F.R.M.S., will give his second lecture-demonstration: "The Making of Microscopical Preparations: (2) Imbedding and Section-Cutting."

# Water Fleas.

**By Sir Arthur E. Shipley, G.B.E., F.R.S.**

*It was while observing these little creatures that the great scientist Metchnikoff noticed how the blood corpuscles eat up invading bodies. The water flea is one of the commonest of our pond crustaceans, yet the male is relatively rare and seldom found by the pond hunter.*

AMONGST the more primitive of Crustacea is a group of small animals known as the *Cladocera*. These are small animals, but the females often reach a millimetre or more in length. They are very widely distributed throughout the world, and they occur not only in fresh water but in the ocean. Two of the commonest of these little creatures found widely spread through the old and new worlds are called *Simocephalus* and *Daphnia*. The body of these animals is enclosed in a chitinous shell which is fused with the head end, but for the last three-quarters of the length of the animal it is free. It hangs down in two wide flaps just as the valves of a mussel or clam shell do. It envelops the body very much like a lounge-coat, only, of course, a lounge-coat is not fused with the head.

The thorax is generally folded forward beneath the surface of the body, but can be protruded from between the hinder edges of the shell.

The head and body bear a number of appendages. These are as follow :—

The first antennae, which are rudimentary and bear a few hairs, which are believed to be olfactory in function. The second pair of appendages are the second antennae which are large and stout and take a large part in the swimming movements of the animal. These second antennae are very conspicuous. They stretch out in front of the little creature and incline backward.

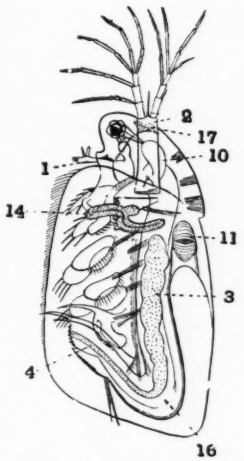



FIG. 1.—SIDE VIEW OF MALE *SIMOCEPHALUS SIMA*. Highly magnified.
1. Antennules. 2. Antennae.
3. Testis. 4. Vas deferens.
10. Hepatic diverticulum.
11. Heart. 14. Shell-gland.
16. Mid-gut. 17. Neck organ.

**Leaf-like Legs.**

They are very much like the arms of numerous little men in Edward Lear's illustrations of "The Book of Nonsense," and as these little men wear little jackets there is a somewhat ludicrous resemblance between *Daphnia* and them, though it is quite impossible that any Cladoceran should ever have seen this work, and extremely improbable that Mr. Edward Lear ever saw a *Daphnia*. Then come a pair of biting mandibles, and then the first pair of maxillae. The second pair of maxillae have disappeared. At this point the thorax begins and bears five pairs of flattened, leaf-like legs. These are continually waving to and fro, producing a current which flows through the shell, bringing with it food and oxygen. Behind the fifth pair of legs there is an unsegmented abdomen which, with the thorax, is usually bent under the body. The shell is to some extent transparent, and one can generally observe the curved alimentary canal, which has a pair of digestive glands opening a little way behind the mouth, for this tube is generally packed with coloured food. It opens on the exterior of the upper side of the tail. Then one can also make out the shell-glands, which act in these small animals much as a kidney does. These lie between the walls of the valves of the shell and open in the region of the second maxillae which are, however, wanting. The nervous system consists of a brain with a large nerve to the eye and of a series of segmented ganglia supplying the appendages of their neighbouring parts.

**Single Eye.**

These can all be faintly made out. The sense organs consist of a very large eye which is the result of the fusion of the middle line of the two lateral eyes. This eye is moved hither and thither by three muscles, and when they contract the eye, like that of the poet, appears "in a fine frenzy rolling." Besides this it has a perpetual quivering motion, as if it were always winking, or, at any rate, twinkling. In the embryo the two eyes are distinct; later in life they fuse. Besides this, there is a small median pigmented spot which represents what is left of the crustacean central eye, just as our pineal gland represents what was an eye in the lower vertebrata. The faculty of smelling is attributed to many of the hairs which are found on the antennae.

In the female we can also distinguish the ovary, and in the rare specimens of males the testes, and the beating of the little creature's heart can be counted. This last-named organ has but one pair of openings or ostia, and when it collapses these close and the

blood is forced forward in a stream which, although there are no definite blood vessels, always follows the same course. It streams through the thin leaf-like legs which flap to and fro. It also streams between the inner and outer walls of each flap of the shell.

*Daphnia* has a certain historical interest, for it was in this little creature that Metchnikoff observed some of the earliest examples of phagocytosis. This great Russian zoologist observed that certain sharp spores of a fungus known as *Monospora*, when swallowed by the *Daphnia*, pierced the walls of the intestines and, getting into the "body cavity," were eaten up and put out of action by the amoeboid-like corpuscles in the blood of the *Daphnia*.

**Casts.**

The ovary lies alongside the intestine and opens at the beginning of the thorax into the space between the body and the upper part of the shell. Here is a roomy cavity and here the eggs develop, generally several at a time. They are prevented from tumbling out behind by the presence of a couple of spur-like processes projecting from the upper side of the abdomen.

From time to time the animal casts its cuticle as do all the crustacea, and it does this with extreme rapidity, taking less than a minute for the whole process. The shell is chitinous for the most part, but strengthened by a certain amount of calcareous deposit. It does not seem quite clear how many ecdyses take place, but when one does occur, the shell cracks and the head part separates from the two shell flaps. The head is then almost free and through the split which has been formed first the head and then the shell flaps and then the hinder part of the body push their way out. In the meantime the shell has also split along its middle dorsal line, and this helps in the escape of the body from the cast-off cuticle. During this process all movement is slowed down, the lashing of the feet and the beating of the heart almost cease. The freed Water Flea is extremely transparent and for the moment very soft and weak. It remains quite quiet, the legs languidly moving, but as the minutes pass it darkens and becomes stronger. For a time it fasts, but somewhere between the fifth and ninth hour it begins to feed and to "sit up and to take notice." In the course of a day the animal becomes normal.

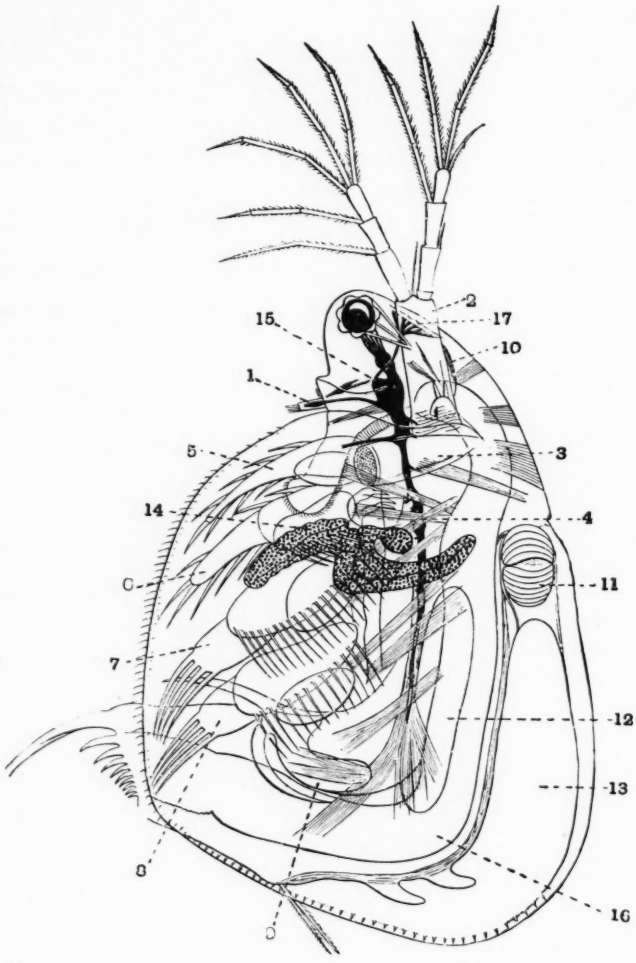



FIG. 2.—SIDE VIEW OF FEMALE *SIMOCEPHALUS SIMA*.
Magnified to the same extent as Fig. 1. From Cunnington.

1. Antennules. 2. Antennae 3. Mandibles. 4. Maxillae. 5. First pair of legs. 6. Second pair of legs. 7. Third pair of legs. 8. Fourth pair of legs. 9. Fifth pair of legs. 10. Hepatic diverticulum. 11. Heart. 12. Ovary. 13. Brood-pouch. 14. Shell-gland. 15. Brain. 16. Mid-gut. 17. Neck organ.

**Activities.**

The Cladocera swim actively through the water, sometimes head forward, sometimes breast forward, sometimes upside down. But they are fond of resting and *Simocephalus* will hang on with certain curved hairs of its antennae to any slightly roughened surface and will remain in the same place for a considerable time. Whilst resting, the legs will beat at an amazing rate, not less than 300 strokes per minute, though these may in cases slow down. The heart beats almost at the same rate, but there is no exact correlation between the movements of the limbs and of the heart. As a rule the heart beats rather more slowly.

One of the most remarkable features of the Cladocera is their method of reproduction. The eggs, when laid, pass into the space under the shell above the body and here they undergo their development. They pass through the well-known nauplius stage which is so common in the crustacea ; but this stage exists only whilst the embryo is in the egg-case. The little creatures actually hatch out as miniatures of their parents. During most of the year all the specimens of this very widely distributed group are females, which reproduce their kind parthenogenetically or without fertilization. This condition of things may last on, should the winter be mild, till Christmas time, but with the onset of cold weather some of the eggs hatch out as males. The male is a small, puny, insignificant copy of the female, as is so often the case with males of all classes of animals until we reach the Vertebrata. It, however, fertilizes the eggs of the female and these eggs, passing into the brood-case, develop up to a late stage of segmentation but no further. Soon after their arrival in the brood-case the shell is thrown off, but part of it remains as a coating to the eggs and this is called the ephippium. Surrounded by this protective casing the eggs lie dormant through the unfavourable times ; with the return of warmth and brighter conditions the eggs continue their development and hatch out as parthenogenetic females, which continue to reproduce their species asexually. In some species there is a second period of sexual reproduction in the summer, the cause of which is not very clear. As a rule there are only two winter eggs within each ephippium. They float about near the surface, or, if the pond dries up, lie buried in the mud, and in this way they can be sent all over the world and hatched out by those who wish to study foreign species. The number of summer eggs may, in *Daphnia*, amount to some thirty, while others, *e.g.*, *Simocephalus*, has rarely half that number, and in the ephippium of the last mentioned genus there is only one egg instead of two.

### Response to Changes.

Water Fleas are attracted to the light, that is to say, they are positively phototropic. They will pass from a dark place to a lighter place Possibly this may have something to do with their feeding, for the same stream which brings oxygen to the leaf-like legs brings also some unicellular plants, diatoms, etc., which in some rather mysterious way collect along the ventral surface of the animal between the bases of the appendages and are swept forward towards the mouth, where they are engulfed between the mandibles. Animal food seems less common than vegetable. Recent observation has shown that specific gravity plays some part in the vertical distribution of such creatures as *Daphnia*. There are so many factors at work, the temperature of water, its density, light, and many other agents play a part in the rise and fall of the Water Fleas in the ponds in which they live. The specific gravity of *Daphnia pulex* varies with the amount of food in the intestine and the number of young in the brood pouch. The release of the latter cause an instantaneous decrease of specific gravity of the mother. There is also a diurnal variation in the specific gravity of animals of the same size. It varies at different periods of the day and night, being at its maximum before sunrise and approaching its minimum by noon.

## A NEW SUBSTITUTE FOR GLASS.

THE latest chemical discovery is a substitute for glass, made from purely organic materials. It seems to have many attractive properties, being much softer than glass, so that it can be worked on a lathe into all sorts of required shapes. It can be coloured for decorative purposes, but the most interesting thing about it is that its refractive index can be varied over a wide range, making it very suitable for optical instruments and capable of replacing very expensive kinds of glass in telescopes and microscopes. Another interesting optical point is that it appears to be much more transparent than glass to the invisible rays—ultra-violet and infra-red light. It may be a surprise to those who have not heard of synthetic resins, to hear that this glassy substance is made by condensing formaldehyde and urea. At first a kind of soft, transparent jelly is obtained which, with the aid of a little heat and addition of traces of some sodium salts is converted to a hard glassy material which has the properties already described.

It will probably cheapen optical appliances to an unheard-of degree and supersede the expensive fluorite lenses of apochromatic objectives and may find therapeutic application as a substitute for glazing in hospitals.

## GOLD GLASSES.

FOR many years it has been known that a thin leaf of gold will permit light to pass through. An ordinary sheet of gold-leaf shows the effect perfectly. The transmitted light is green. A new application of this property is reported from America. Glasses are made with a thinly deposited gold surface. These are said to arrest the heat and ultra-violet rays but to pass the light waves through. The device may find application for use by furnace workers.

THE FACIAL ASPECT
(Half natural size).
(By courtesy of *Nature* and *The Illustrated London News*).

# The Newly-discovered Fossil

By E. N. Fa

*An authoritative article on the Taungs skull found by Professor Raym comparison of this sku*

ATTENTION has again been called to the importance of South Africa as a field of prehistoric research by the announcements of the discovery of a new fossil anthropoid in Bechuanaland which appeared in the daily Press of 4th February and succeeding days. It is perhaps not surprising that the form of the original announcement should have led to its being hailed, somewhat prematurely and inaccurately, as the discovery of the "Missing Link." The interest of the discovery, though not quite so sensational, is very considerable, and there can be no doubt that these remains, when submitted to fuller examination and study, will prove to be a notable contribution to our knowledge of the evolution of man and the higher apes. A preliminary report by Professor Raymond Dart of the Witswatersrand University, Johannesburg, by whom the discovery was made, appeared in *Nature* on 8th November. By the courtesy of the editor, three of the illustrations which accompanied that report are reproduced here. A full account is to appear shortly in a monograph now in course of preparation, the publication of which will be awaited with keen interest.

The remains consist of a natural cast of the interior of a skull and the greater part of the bones of the face belonging to the skull. The circumstances of their discovery are in themselves interesting. They were found among a number of fossil remains of *Cercopithecidae*—baboon-like apes—which Professor Dart had under examination. These had been obtained from a limestone cliff formation at Taungs, about eighty miles north of Kimberley, where blasting operations were in progress at a point 50 ft. deep vertically and about 200 ft. in from the face of the cliff. Among the cercopithecid fossils obtained here were two natural casts of the interior of skulls which had been formed by limestone deposit penetrating the cranial cavity. Of these endocranial casts one was considerably larger than the other, and to this Professor Dart was able to fit accurately other fragments which showed pieces of bone. On clearing away the deposit adhering to the bones he found that they formed the nearly complete facial skeleton belonging to the skull. Professor Dart's experience of fossil remains at once led him to conclude that the fossil was one of considerable importance. It was clear that he was dealing not merely with remains which did not belong to the group of *Cercopithecidae*—this was obvious from the first owing to their size—but further examination led him to believe that this skull had belonged to a creature like no anthropoid hitherto known.

### Appearance of the Skull.

In the preliminary report which appeared in *Nature* Professor Dart describes in some detail the principal characters of the skull with special reference to its approximation to human character. This approximation, he holds, is apparent in every one of its more important features. The skull as a whole is said to be broadly humanoid in appearance, a statement which can be verified from the two photographs reproduced here which show the full- and side-face views. Although the upper part of the skull is not present, it is possible to estimate its length from front to back. It falls into the dolichocephalic group—that is, it is long-headed and not broad-headed as might be expected. Further, it is harmonious in the relation of its parts: the length of the head does not show that disproportion to the length of the face which is found in the apes. The forehead is more upright than in the anthropoid and, indeed, it does not show even the degree of slope found in the long, low, receding forehead of Neanderthal

# d Fossil Ape-man of South Africa.

**By E. N. Fallaize.**

*by Professor Raymond Dart, explaining how experts draw conclusions from the parison of this skull with others.*

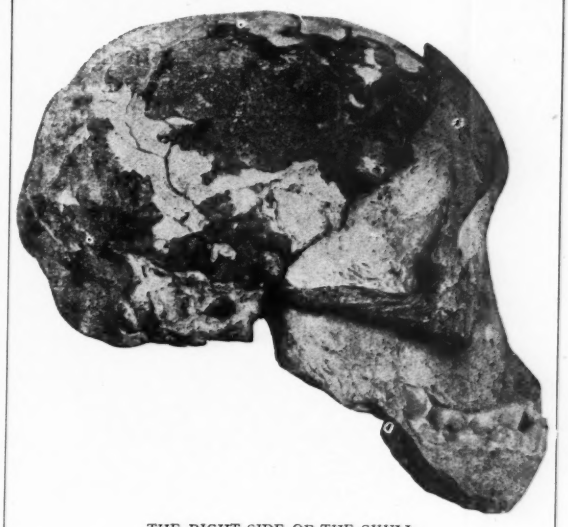
man. A comparison of the profile of the Taungs skull, of the gorilla and of the chimpanzee shows that the projection of the lower part of the face is relatively slight, and not nearly so marked as in the anthropoids. Another feature in which it differs both from the anthropoids and the earliest human skulls is in the absence of the prominent eyebrow ridges, which are among the most marked characters in the skulls of the apes, of *pithecanthropus erectus* or Java man, of the Neanderthal group, and of Rhodesian man. In Piltdown man alone among these early skulls are they absent.

### Jaw Characteristics.

The shape of the orbits of the eye, as can be seen, is almost circular, while in the anthropoids it is sub-quadrate ; their position and appearance are distinctly human. The form and character of the nasal bones in certain respects also present human features.

One of the most important and significant features in determining the classification and relative position of a primitive type of skull is the shape and general character of the jaw. It will be remembered that in the case of Piltdown man the jaw bone which was found near the skull was of such a heavy type that it was thought that it could not possibly be human, and must be that of a chimpanzee. It was only the reconstruction of this skull by Professor Elliot Smith and the late Dr. John Hunter that demonstrated the compatibility of skull and jaw. In the anthropoids and particularly in the gorilla the jaw is strong and massive. Further, the chin recedes sharply. In the case of the Taungs skull the jaw, as a whole, while distinctly heavier than that of man, is less massive than in the anthropoids. It appears to represent something like an intermediate type. The chin has a more vertical outline than even the Piltdown skull, while that portion of the bone at the hinder part of the jaw which ascends to articulate with the skull is here short and slender on the whole as compared with that of the anthropoid.

The character of the teeth again is a matter of great significance. In anthropoids they are distinctive. Professor Dart regards those in this skull as being of a distinctly human type, both in form and position.



THE RIGHT SIDE OF THE SKULL
(Half actual size).

(Reproduction by permission of *Nature* and *The Illustrated London News*).

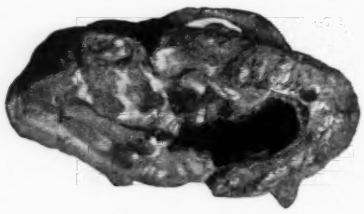
It must be mentioned, however, that they belong to the milk teeth set and indicate an age which would correspond in a human being to about six years. It is apparent, therefore, that the evidence of the teeth must be accepted with some reserve. As Professor Dart himself points out, very little is known about the milk dentition in anthropoids, and in an immature specimen it would thus be unsafe to draw any very positive conclusion from the teeth.

A conclusion of no little interest is drawn from the position of the *foramen magnum*—the aperture at the base of the skull by which the spinal cord enters. The position of the *foramen magnum* is mechanically connected with the upright posture which, when adopted habitually, necessitates an equipoise of the skull on the spinal column. In the human, therefore, the foramen is situated farther forward that it is in the apes who normally walk prone and adopt the upright posture for comparatively short periods only. In Neanderthal man, where the foramen is farther back than in modern man, the head was habitually thrust forward. Professor Dart maintains that he has been able to fix the position of the foramen in the Taungs skull with approximate accuracy at a point midway between that in Rhodesian man and in the baboon. If correct this would place it more nearly centrally than in the anthropoid. Professor Dart therefore concludes that his ape-man was beginning to assume

the upright posture habitually, and that his forelimbs were thus freed more constantly for the specific use of touching and handling objects, leading to a corresponding development in intelligence. In default of any evidence as to the character of the bones of the lower limbs, this conclusion perhaps goes a little far.

### Brain Cast.

In estimating the stage of development in intelligence attained by any primitive form, whether human or anthropoid, the brain must necessarily play an important part. The cast of the inside of a skull furnishes



BASE OF THE SKULL.
(Reproduction by permission of *Nature* and *The Illustrated London News*.)

a general idea of the form and development of the brain. The work of Professor Elliot Smith has shown that by means of such endocranial casts of primitive skulls it is possible to arrange them in a developmental series which is confirmed by, and itself corroborates, the evidence of skeletal characters and archaeological evidence when this is available. If, therefore, further examination should confirm the conclusions which Professor Dart has drawn from the character of the endocranial cast this will prove one of the most important pieces of evidence with which we have to deal. Allowing for its immaturity as indicated by the teeth, in size it is relatively larger than that of a gorilla. The cranial cavity appears to have been about 114 mm. in length, which would make it 3 mm. greater than that of an adult chimpanzee in the Museum of the Anatomy Department in the Witswatersrand University, and it is only 14 mm. less than the endocranial cast of a gorilla which was chosen for the purpose of a cast on account of its great size. It might therefore be assumed that in the adult the brain would be absolutely greater in volume than that of a gorilla. It has to be remembered, however, that very little is known of the amount and rate of the growth of the brain in immature anthropoids, and it is not impossible that that growth may stop at a relatively early age.

With regard to the quality of the brain it is said to show a distinct enlargement of the temporo-parietal areas, the "association areas," as compared with the anthropoid brain, again varying in the direction of the human. In his study of the evolution of the brain, Professor Elliot Smith finds the development of these areas to be directly connected with the evolution towards specifically human intelligence and associated with the development of stereoscopic vision, the assumption of an upright posture and increased use of the forelimbs for purposes other than progression. It indicates an increase in the power of storing and comparing information acquired by the senses of touch, sight and hearing, which Professor Dart says, "was a necessary milestone in the acquisition of articulate speech." This increase would have been a concomitant of the augmented power of handling objects which would have been allowed by a greater habituation to the upright posture. To this extent it tends to confirm Professor Dart's views on that point.

The points in which *Australopithecus Africanus*, as Professor Dart has elected to christen his discovery, varies from the chimpanzee and the gorilla in the direction of the human, are in a sense crucial. Of these the most significant are undoubtedly the jaw and the size and development of the brain; but of the latter it is premature to speak positively in view of its immaturity and until accurate casts are available for study, although there is no reason to doubt Professor Dart's accuracy. Yet caution should be exercised lest *undue* stress be laid on such similarities. Full allowance must be made for the age of the being to which the skull belonged and for the fact that in the anthropoid the characters which differentiate it from the human are by no means so strongly marked at the early stages of growth as at maturity. Nevertheless, the cumulative effect of the variation of so large a number of significant characters in the direction of the human is considerable. It gives ground for the conclusion that while *Australopithecus* is to be classified as anthropoid, it represents an appreciable advance along the line of progress. In other words, the Taungs skull would seem to belong to a group which must have branched off from the main line of descent at a later stage of development than the ancestors of recent anthropoids.

### Age Still Unknown.

The conditions of the discovery, beyond pointing to a considerable antiquity, do not give any great assistance in arriving at an estimate of the time at which *Australopithecus* lived. It is to be presumed that the remains had originally rested in a cave such as is typical of limestone formation as happened in the case of Rhodesian man. If all traces of this cave had been obliterated by limestone drip some

(*Continued on page 106.*)

# Weather and Long-range Forecasting.

By Sir Gilbert Walker, F.R.S., Sc.D., Ph.D., M.A.

*Can we foretell the weather? Is long-range weather forecasting founded on any scientific principle or is it purely a matter of guessing? This authoritative article summarizes the situation and analyses the results of some forecasting systems.*

THE belief in the possibility of predicting the character of the coming seasons depends so largely on ideas regarding the nature of the universe that its discussion can scarcely be separated from that of the general development of thought. Primitive races consider that when a man dreams his spirit actually witnesses the events that his imagination produces, and to the ancient Jews this was nothing very surprising when Pharaoh had a dream which implied foreseeing fourteen years ahead; it was only the interpretation of the dream which required special ability. In the Golden Bough will be found many examples of the belief of existing uncivilized tribes in their ability even to control the weather; and in India to-day there are many in high position who, as orthodox Hindus, are troubled by no doubts over the ability of the astrologer to inform them regarding the coming rains, while almanacs containing such predictions are printed in large numbers for general information.

Such fundamental superstitions are very hard to uproot, and there are many in the west as well as in the east whose scepticism regarding the popular religious beliefs does not enable them to overcome all their inherited instincts, however illfounded. So, although the majority in England recognize that the universe is capable of a rational explanation, this faith is not strong enough to prevent them from placing mascots on their motor cars, or attempting to obtain rest for their own spirits by employing mediums to disturb those of their deceased relations. Their latent belief in astrology shows itself in a conviction of the influence of the moon, if not of the planets, on the weather; and features of the cults of many local deities may, perhaps, survive in the meteorological importance still attached to about fourteen of the saints' days.

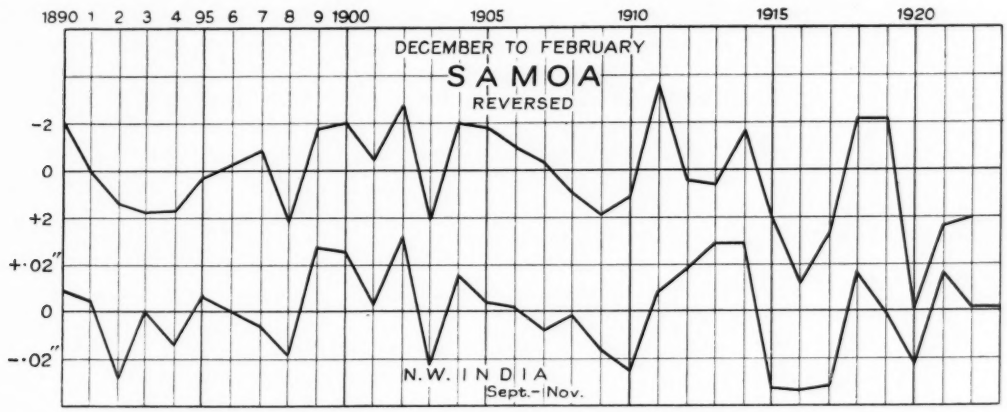



FIG. 1.

In 1900 M. Demtchinski announced that the attraction of the moon was the chief factor in determining the weather, and claimed ability to make long-range forecasts; but his activity, though successful for a time, did not last long. Similarly in India, between 1902 and 1909, simple calculations based on the positions of the sun and moon enabled Mr. Clements to command a respectful and sympathetic attention for his predictions of weather months ahead; and newspaper correspondents testified to his success although the simplest reasoning showed that his methods, which he published, led to conclusions far different from those which he drew. In 1903 Professor Garriott, of the Washington Weather Bureau, said "To-day fakirs and charlatans in the various professional and scientific fields, astrologers, fortune-tellers and long-range weather forecasters command, in civilized communities, a lucrative following." To-day there

are individuals who claim to produce rain at will, and have been treated with serious consideration by governments as well as by private citizens. There is, for example, in America one who employs a large tank twenty feet high, containing a chemical mixture "to open up the clouds"; he only asks for payment by results and is extensively employed at the rate of three thousand dollars for each inch of rain that he produces. It must be a potent drug that can lead to condensation thousands of feet above under these conditions!

### Monsoon Forecasts.

Of official long-range forecasts in modern times the first were due to the need in India of some warning of the terrible famines produced from time to time by failure of the monsoon, causing losses of millions of lives and costing crores of rupees; and in 1884 Blanford began to issue predictions of the rains, based on the amount of winter snowfall in the Himalayas, an excess of which had been noticed in several years before seasons of drought. As his successor Eliot recognized, snowfall exercised only a partial control; and while very prejudicial snow conditions would justify an unfavourable forecast, the mere fact that in any year snowfall was scanty afforded no guarantee that other causes would not impede the monsoon. Eliot tried to increase reliability by considering pressure in the Indian ocean, holding that a high barometer at Mauritius would lead to stronger northward moist winds into India and so a more abundant monsoon; unfortunately, however, this idea, though founded on a natural instinct, was not in accordance with the data, and the success which he achieved was so small that latterly, with his complete assent, orders were passed that his predictions should be treated as confidential documents, and not revealed to the public until the period covered by the forecast was over.

Seasonal predictions were in the meantime initiated in S. Africa and in Australia, both based on belief in control by cycles. Thus in 1889 Hutchins of Cape Colony maintained that a cycle of 11.11 years, not agreeing always with the irregular sunspot period, and a secondary storm cycle of 9.5 years afforded "a complete key to the Cape Town weather"; for the rainfall of S.E. Africa and Mauritius he introduced further "mitigation rains" with a 12.5 years' period. In Australia the period which was announced by H. C. Russell of Sydney in 1896, as dominating droughts there and over much of the world, was of 19 years. However, this use of cycles, based on a rather superficial though painstaking study of many past records, collapsed so badly in practice that seasonal predictions were brought to an end in both countries.

In India it was realized in 1904 that the problem was too difficult for solution by *a priori* methods and recourse was had to examination by statistical processes: it was clearly necessary to find empirically what are the reliable relationships between weather conditions in various parts of the earth before attempting a general theoretical discussion. Obviously, if there is a close association of weather in a region A with that of a region B three months later, a knowledge of the conditions in A may be used for anticipating the subsequent weather in B. In 1908 a preliminary examination led to a formula for forecasting the monsoon rainfall of the whole of India, and a relationship* of 58 per cent with the actual rainfall was indicated; and during the sixteen years 1909-1924 the formula has fully answered expectations. So small a relationship as .58 does not justify a forecast unless the abnormalities are fairly marked; but this condition has been satisfied in nine years out of the sixteen, and in eight years out of the nine the rains were in excess or defect when this was given by the formula.

As we shall need an idea of the values of relationships of this kind for purposes of forecasting, some further consideration is necessary. Taking the simplest case, in which either an excess or a defect of rain is predicted, success turns on the condition that the probable error of the estimate of the amount of rain shall be less than the amount of excess (or defect) indicated by the data; and, in fact, smallness in the relationship both diminishes the amount indicated and increases the probable error of the estimate.

### The Basis of Calculation.

If we decide that it is useless to issue forecasts that will not, on the average, be right four times out of five, it follows mathematically that if the relationship be 80 per cent circumstances will justify a forecast in half the occasions; if 70 per cent there is a 3 to 2 chance against the indication of any one occasion being definite enough; for 50 per cent the odds are 6 to 1 against; for 40 per cent 18 to 1; for 30 per cent 130 to 1; and for 20 per cent 25,000 to 1. So unless the relationship is of 50 per cent occasions for a justifiable prediction will occur too rarely for practical

* In technical language there was a correlation co-efficient of +·58, implying that an average fraction of 58 per cent of the variations of the actual rainfall would be provided by the forecast. If the coefficient is unity the agreement is perfect, if it is zero there is no connexion between the actual and the predicted, and if it is *minus* one the forecast would have to be reversed to become perfect.

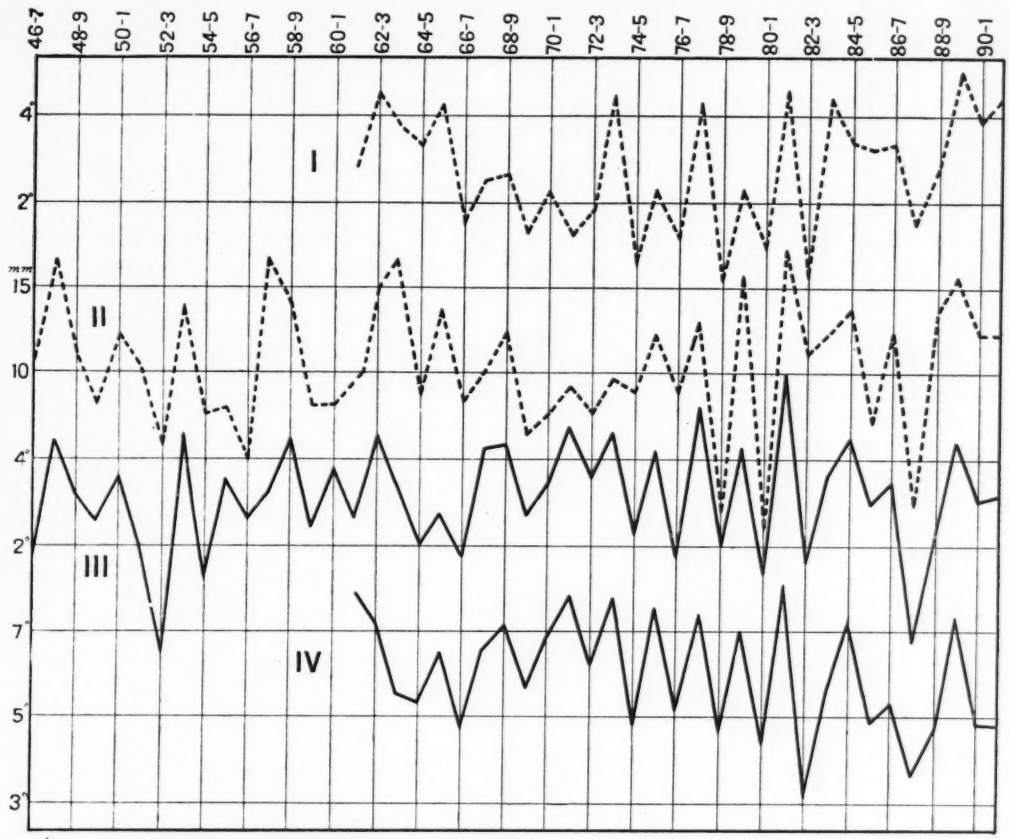



FIG. 2.

purposes. These figures would be modified if forecasts of normal conditions were also made, but the general result would not be fundamentally different.

During the past fifteen years a general survey has brought to light many relationships of which that illustrated in Fig. 1 is among the most striking. The pressure in N.W. India for the quarter September to November exercises a strong control over that at Samoa in the Pacific Ocean in the succeeding quarter December to February, high pressure in one area being associated with low in the other and the amount of correlation being 70 per cent; the data of N.W. India are plotted year by year in the lower curve and those of Samoa inverted are above.

The effect of the survey is that improved formulae are now available for the monsoon rainfall of N.W. India and for the Peninsula with expected relationships of 76 per cent, and for the winter rainfall of N.W. India with the same relationship; if these formulae fulfil expectations as did that of 1908, a problem of great importance to India will have advanced a stage towards solution.

Methods similarly based on a statistical examination were subsequently adopted for a time in Egypt, and they have been introduced by Okada in Japan, and C. L. Robertson in Rhodesia; the predictions of Braak in Java depend on an intensive study of the local pressure conditions.

The question naturally arises whether the processes of forecasting that are establishing their value in the east are useless in Europe; and a most hopeful prospect, for some countries at least, may be derived from an article published as far back as 1898 in the standard continental meteorological journal (*Meteorologische Zeitschrift*, XV, pp. 85-105), from which Fig. 2, giving data from 1846 to 1891, is taken. It

will be seen that either the temperature on the coast of Norway in November and December (curve 1), or the pressure difference, Copenhagen *minus* Iceland from September to January (curve 2), affords an excellent idea of the character of the spring (March and April) temperatures in the area from Copenhagen (curve 3) to Berlin (curve 4).

### European Predictions.

Doubtless the reason why prediction of the seasons has not received very much attention in Europe is that dread of famine has not forced any government to take up the question. But there is a demand for forecasts of a short period ahead for agricultural purposes, and the London Meteorological Office has occasionally issued notices when fine weather was expected to last perhaps for a week. The motion of cyclones and of the secondaries that form in them involve so many complications that, as far as I am aware, no serious attempt to foreshadow their positions three weeks ahead has ever been published. But, undaunted by professional inability, the *Field Newspaper* has for some years displayed the courage and enterprise involved in issuing weekly long-range forecasts of rain day by day for the British Isles, divided into districts—in 1921 up to nine and a half weeks ahead of the day of issue and more recently to six and a half weeks ahead. They have also lately initiated seasonal forecasts of weather in more general terms. As the former contain far more material and lend themselves more readily to definite numerical tests, we propose to apply the ordinary statistical analysis to them. In the first place we need some idea of the continuity of rainfall, and therefore of the success that would be attained if we forecasted this week's rainfall as likely to occur next week, or in the week after; and the following table shows the percentage relationship given by a numerical analysis of the actual rainfall of division No. 3, for S.E. England including London.

| | One week later. | Two weeks later. | Three weeks later. | Four weeks later. |
|---|---|---|---|---|
| For 52 weeks, ending 3.2.'23 to 26.1.'24. | + 6 | + 24 | + 30 | − 8 |
| For 36 weeks, ending 2.2.'24 to 4.10.'24. | + 24 | + 30 | − 6 | + 10 |

This means that during the year from February 1923 to January 1924 the consecutive weeks of rainfall had very little connexion, only six per cent of their variations being in sympathy; but for rainfall two weeks apart the percentage was twenty-four and three weeks apart thirty, while for four weeks apart there was trifling opposition. In 1924 the results are more what might have been anticipated. Probably a long series of years would give something like twenty-five per cent for the first week, twenty the second, and ten the third.

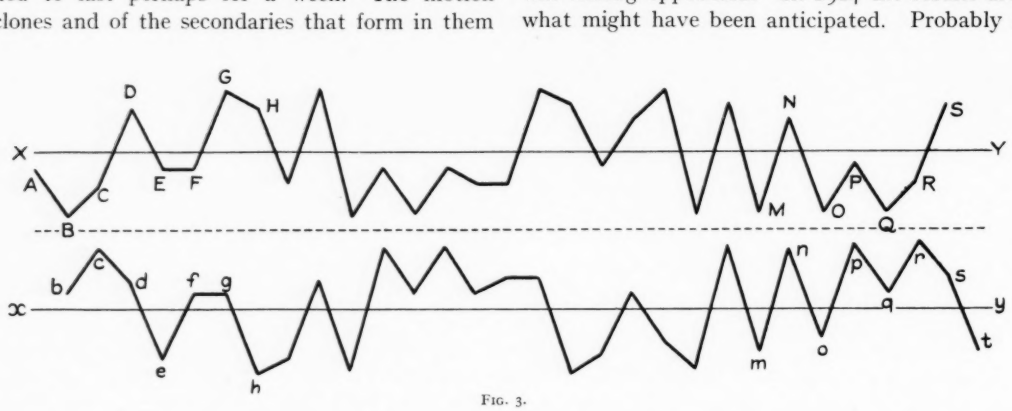



FIG. 3.

### Analysis of *Field* Forecasts.

Let us now compare with these the success attained in the forecasts, and in order to make the dates clear let us take, as an example, that issued on the 14th August, 1924; this was prepared on the 11th, and gives the anticipated rain falling on each day from 10th August to 3rd October. The rainfall data for S.E. England are published in weekly averages by the London Meteorological Office, and as the *Field* forecasts, though given in daily amounts, are clearly stated not to claim daily precision, it will be fairest to compare the total of the week as forecasted with the total actual rainfall of the week; forecasts correct except for an error of one or two days in the date of occurrence will then produce good agreement Also the vertical scale of the *Field's* diagrams

is constant through the year, though rainfall is heavier at some seasons than at others; and it therefore appears fairer to compare the weekly forecasted amounts, as derived from measuring the diagrams with the ratio of the week's actual rainfall to its normal amount.

### A Double Problem.

Now there are two distinct questions to be answered. How good is the forecast for the contemporary week, *e.g.*, that falling for the days 10th to 16th August, prepared on the 11th and issued on the 14th? And how good is a forecast of rainfall four weeks ahead or six weeks ahead? The first task should be tackled by a capable trained forecaster with a certain measure of success if he is provided with the information available from ships of the position of cyclones in the Atlantic; but even then the difficulties would be considerable, and his success would fall very far short of that reached in ordinary daily forecasting. The numerical analysis gives, from the forty-six predictions in the issues from 13th September, 1923, to 28th August, 1924, a percentage relationship between the forecasted and actual total rainfall of the contemporary week (*i.e.*, as forecasted at its beginning) amounting to thirty-one; and, in view of the difficulties, this is evidence of the ability which we should confidently expect in one of our leading weeklies. Estimated by the number of weeks in which the rainfall was in excess or defect as predicted, there were 28 right and 17 wrong; the odds were thus 5 to 3 in favour of success as compared with even chances produced by spinning a coin. On the other hand, when we turn to the predictions four weeks ahead, the fifty-two forecasts issued between 11th January, 1923, and 10th January, 1924, yield a percentage relationship of twenty-four, while the thirty-two from 10th January, 1924, to 28th August, 1924, yield *minus** two; and the predictions seven weeks ahead for the twenty-six weeks 11th January, 1923, to 5th July, 1923, give seventeen; for the twenty-six weeks from 12th July, 1923, to 3rd January, 1924, give *minus* twenty-seven; and for the thirty-seven weeks from 10th January, 1924, to 17th September, 1924, give fourteen. Thus the predictions four weeks ahead of the issues have an average relationship of something like fifteen, while those seven weeks ahead will have less value. The four-weeks forecasts were right 40 times in 77, the odds in their favour being approximately 13 to 12; and the seven-weeks forecasts 42 times in 85, the odds being 43 to 42 against correctness. In the present state of knowledge an Isaac Newton would probably do no better.

To a charge of overestimating the reliability of their methods there are few meteorologists, professional or amateur, who can always maintain a plea of "not guilty," and it is in general only unhappy experiences that will cause them to reject all processes that cannot be shown to possess adequate trustworthiness—say four times right out of five. How many a man has noticed that in two sunspot cycles of eleven years there has been more rain or higher temperature about the times of numerous spots than of few, and has assumed that control by sunspots could be inferred! But if he had met two Poles and two Hungarians, and the former pair were more wealthy than the latter, he would hesitate to announce that as a people Poles must be richer than Hungarians. Even Meldrum's relationship of sunspots and cyclones which, between 1847 and 1873 had a relationship of sixty-one per cent, has to be abandoned when the data now available are taken into account; yet in his time there were long odds in favour of its reality, and he would have been fully justified in using it for purposes of prediction.

### Some Sources of Error.

There are also more subtle traps such as that into which the writer once fell, and his fate has not deterred others, especially in Japan and America, from wandering in the same perilous region. If we plot the annual values of two factors and the curves so obtained tend markedly to run parallel to one another, there is a strong temptation to think that the two factors will have a high degree of relationship, *i.e.*, that when one is above normal so will the other, and vice versa. Those who incur this risk will, without employing safeguards, use the changes from year to year instead of the actual values; for, as Fig. 3 shows, the parallelism of PQ to pq depends on the difference of the values of P and Q being roughly equal to the difference of the values of p and q. If mere changes from year to year (or parallelism) could be used as a basis for forecasting the actual values a curious paradox follows; for it may be shown that any series whatever, of rainfall or winnings at cards, could be predicted with a relationship of fifty per cent. All that we have to do is to plot the actual values A, B, C, D—R, S, which in the diagram represent an absolutely random series of the numerals one to nine measured upwards from the dotted line, drawn five from XY; and below this we draw the previous curve inverted and shifted one division to the right;

* A negative relationship will lead to a smaller percentage of successful forecasts than the fifty which would result from tossing a coin.

thus from A which is unity below XY we derive b which is unity above xy and is vertically opposite B, and in the same way D, three units above XY, gives e three units below xy. To most eyes the parallelism of these curves suggests the possibility of forecast, for when we want the next value to M we plot the lower curve to n and draw MN parallel to mn. This is a delusion, for while the relation between the charges is in this case sixty-four per cent, that between the actual values is only fifteen, an amount quite useless for forecasting. These figures would average fifty and zero on a number of chance series.

It must regretfully be admitted that the majority of the methods employed in seasonal predictions have been false; and insistence on strict conformity to the rules—in other words the principles of probability—is not mere pedantry. The larger variation of seasonal rainfall, pressure and temperature are in general not isolated phenomena, but are linked up with big variations in other parts of the earth, so that there is every cause for hopefulness regarding the possibility of understanding and predicting them; but many researches needing time and money are first necessary, and it is highly desirable in the interest of meteorology that as little as possible should be done by careless work to diminish public confidence in the possibilities of long-range forecasting.

## VARIATION IN AFRICAN LAKE LEVELS:

### Correlation with Sunspot Period.

(*From a Correspondent*).

AN investigation conducted by Dr. F. Dixey, Government Geologist of Nyasaland, indicates that the variation in the level of Lake Nyasa, like the similar variations of Lake Victoria, Nyanza and Albert, shows close parallelism with the sunspot period. In this connexion it is of interest to observe that the great drought of 1921-22 which affected Nyasaland and adjacent regions occurred at a period of sunspot minimum when the levels of lakes Victoria and Nyasa were both falling rapidly and that the drought of 1911-12 also occurred in a period of sunspot and lake level minimum. The Lake Nyasa maxima of 1896-98 and 1917 were immediately preceded by periods of exceptionally heavy rainfall. According to the older residents in Nyasaland famines similar to those of 1912 and 1922 have occurred at intervals of ten or eleven years over a considerable period in the history of the country, and Dr. Dixey thinks that it is not unreasonable to assume that famines will recur at similar intervals unless due precautions are taken to avert them.

In the case of Lake Nyasa the condition of the Upper Shiré river and its capacity for carrying off excess water from the lake must act as an additional but irregular factor influencing the level of the lake. The very low level attained by the lake in 1914, combined with certain other factors, led to such an extensive silting up of the bed of the river that the succeeding maximum failed to give the river sufficient power to scour out its course. Consequently on passing the maximum the lake level fell but slowly; furthermore it began to rise again and rose rapidly about three years before the anticipated minimum. By the early months of 1924 this rise had brought the level almost up to the high maximum of 1896-98 when river traffic was at its best, but even so the river remained practically dry and totally unfit for navigation. Hence during the next few years the lake may be expected to rise again at least to the highest level on record. If this rise enables the Upper Shiré to remove the obstructions from its bed the river may begin to assist again in bringing about a lowering of the lake level and incidentally to become fit for navigation once more until silting again gets the upper hand and the cycle begins afresh. According to native tradition the upper part of the Shiré valley is subject to periodical flooding on a large scale

While fluctuations of considerable magnitude have occurred in the level of the lake during historic time Dr. Dixey thinks that there is no evidence to show that any progressive rise or fall has taken place. This is in accord with the findings of a commission recently appointed in South Africa to inquire into the cause of the disastrous droughts of recent years. It was found that there was no evidence for any progressive increase or decrease in the rainfall of the Union during historic time and that the desiccation observable in many parts of the country was due not to diminished rainfall but to failure of the land to absorb the rain as it fell, consequent on the destruction of natural vegetation, the resulting erosion of the soil and the hardening of the surface of the land by sun-baking and the trampling of cattle.

THE simplest way of cleaning silver is to put it in a solution of common salt and washing soda in an aluminium saucepan. Electrolytic action takes place and removes the tarnish. The method is very efficient for heavily decorated or chased ware with recesses difficult to clean.

# Enzymes—and the Future.

By J. B. S. Haldane.

*The more we know of the chemical process in cells the more important appear to be the functions of the enzymes. A conquest of the cellulose-splitting enzyme might enable us to solve food problems by changing wood into sugar.*

THE chemical processes which take place in a living animal or plant are just as characteristic as its form or behaviour. This does not mean that any given one can be duplicated. Rhumbler made an artificial "cell" which would absorb a glass thread covered with sealing-wax, remove the wax and spit out the thread. Hammond made a motor "dog" with selenium "retinae" which would follow a light on a white object. And similarly we can imitate many of the chemical reactions which take place in the cell, though often we require rather violent means, such as heat or the application of strong acids. What is characteristic of life is not the individual details of structure or behaviour, but the way in which they cohere to form a self-regulating and self-preserving whole.

When we succeed in investigating the details of a chemical process in the cell we generally, if not always, find that it is determined by the presence of an enzyme or ferment, which can be more or less completely separated from the rest of the cell and is not alive. In favourable cases we can break up the cell and, by a series of processes not utterly unlike those employed in extracting the rarer metals from their ores, except that no heat is used, obtain one of the enzymes in a fairly pure state. A solution of cane sugar in water is fairly stable, but if we warm it with a strong acid it breaks up into the mixture of sugars found in honey. This can also be done by enzymes found in plant cells, the saliva of bees, and our own intestines. The most active enzyme preparations when dissolved in water will break up ten times their weight of sugar per second, and, as far as we know, will continue to do so indefinitely. Certainly they can break up more than a million times their own weight without wearing out.

## Enzymes as Catalysts.

The early workers on enzymes believed that a little "vital force" resided in these particles, a belief analogous to that of primitive men in the magical nature of their own tools. But enzymes are certainly not alive. They do not reproduce themselves nor adapt themselves to changes in their environment. They are simply the tools of the cell. Their action is similar to that of inorganic catalysts, such as finely divided nickel or platinum which are used in industry to speed up many chemical reactions or to allow them to occur at a lower temperature than would be possible in their absence. And, although we have not yet been able to make one artificially, and shall not be able to do so for many years, we are gradually elucidating their chemical composition. Many of them would seem to be proteins, and it has been suggested that the protein of certain cells consists almost wholly of enzymes.

## Specialization.

One of the most characteristic things about an enzyme is its specificity. The enzyme which digests cane sugar will not touch milk sugar or malt sugar, and conversely. Enzymes have been compared to keys which will only open certain locks. One might go further and say that they are Yale keys. Many molecules which are attacked by them are asymmetrical, as is shown by the asymmetry of their crystals and the fact that their solutions rotate the plane of polarized light passed through them. We can often make the mirror images of these molecules, and we then find that the corresponding enzymes will only attack them slowly if at all. On going through the looking-glass, Alice would have found her digestive enzymes of no more use on the looking-glass sugars than her Yale key on the looking-glass locks. This asymmetrical behaviour is not, however, peculiar to enzymes. It has been found to hold good for the action of other catalysts, including some synthetic substances.

Our knowledge of enzymes has so far had rather little direct application. Those first studied were the ones found in digestive juices, which break up our food into readily absorbable substances, and are unique in that their action normally takes place outside the cell where they are formed. Preparations of these can readily be made, and one of them, rennet, has long been employed in dairies to clot milk. But no very great success has attended the treatment of various forms of digestive trouble by administering enzymes. The main reason for this is that indigestion is seldom due to a shortage of them. So at the present day, apart from rennet and an extract of the pancreas

used in the partial digestion of hides to furnish certain kinds of leather, preparations of the digestive enzymes are of more benefit to their sellers than their buyers. For example, a mixture containing pepsin is widely advertised as a tooth paste, although pepsin is inactive in such fluids as saliva, a fairly strong acid being needed to make proteins susceptible to its action.

Several diseases and abnormalities are due to the absence of an enzyme, but we cannot cure albinism, for example, by injecting tyrosinase as we cure diabetes with insulin. For insulin appears to have a small enough molecule to allow it to get through the walls of the cells, whilst enzyme molecules are too large for this to be at all easy, and they seem generally to be manufactured on the spot where they will be used. So far, therefore, our efforts in medicine are directed rather to enabling such enzymes as exist in the cell to act more efficiently than to supplying them in their absence. We are now, however, beginning to study the enzymes not only of bacteria but of cancer cells, which seem to be slightly but significantly different from those of normal tissues.

In industry we generally find it better to use enzymes in the cell than out of it. Yeast makes alcohol from sugar much more rapidly than any extract containing the three or four enzymes concerned in the process. But it does a good deal more. The yeast cell breaks up proteins as well as sugar, and from these it forms the fusel oil which not only gives an alcoholic liquor much of its characteristic taste and smell, but also in many cases makes it a great deal more poisonous than its alcohol content would lead one to suppose. It is quite possible, therefore, that if the liquor trade has a future it may be on the lines of utilizing enzyme preparations rather than living yeast cells. When yeast cells are given cane sugar, they break it up into simpler sugars before making these latter into alcohol. The enzyme which they employ for this purpose may easily be separated from those concerned in fermentation. Now the new sugars formed are both more tenacious and more retentive of water than cane sugar, and therefore better material for making sweets. So the use of yeast invertase is spreading in the American candy trade, and if prohibition has raised the consumption of candy, it has not been of entire disadvantage to the yeast plant.

Perhaps the biggest field for the commerical application of enzymes lies elsewhere. Plants make sugar from carbon dioxide, water, and sunlight. A few, like the potato, store most of this in a form that we can digest. But most of them convert it into cellulose, the main constituent of wood. They commonly make a little sugar to attract bees or birds, but man is the first mammal who has seriously befriended plants, and agriculture is so recent that only a few of the more enterprising among them have had time to vary so as to bribe him with food. The cow and horse can no more digest cellulose than ourselves. No animal nearer to us than a snail can make the enzymes requisite for even a partial digestion of it. But an ungulate is a co-operative society. It consists of the mammal which forms the façade, and some millions of millions of bacteria engaged in breaking down cellulose. The products which they form from it are largely digestible by the horse or cow, but would be unpalatable, if not harmful, to man. However, one of the intermediate stages in their production from cellulose is an easily digestible sugar. When—not if—we can separate the cellulose-splitting enzymes from those which break up the sugar further, we shall be in a position to convert wood pulp or hay quantitatively into human food.

This is one of the facts which render dubious all prophecies as to over-population. The upper limit to human numbers is not set by any facts of Nature, but by human ignorance and inadaptability.

## THE NEWLY-DISCOVERED APE-MAN.

(*Continued from page 98.*)

considerable period of time must have elapsed. *Pithecanthropus erectus*, the most primitive type included within the human range, is now regarded as belonging to the early Pleistocene, the first stage of the Quaternary period. It therefore might not be unreasonable to regard *Australopithecus* as belonging at latest to the same era and possibly to an earlier—the Pliocene phase of the Tertiary period.

Of recent years a number of important additions to our knowledge of early man have come from South Africa, of which the most remarkable was the discovery of Rhodesian man, a type possibly in certain respects even more primitive than Neanderthal man, though not necessarily of such high antiquity. The character of the fauna of the area shows that here early types of mammalia, elsewhere extinct, have been preserved until recent times. It is therefore justifiable to look in this direction in the hope that further exploration and investigation, as well as the increased interest with which commercial undertakings in mining or quarrying will be followed owing to the stimulating influence of the discovery of the Taungs skull, may bring to light other relics of early man and further evidence which may throw light on man's descent, as well as help in the solution of the problem of his place of origin, whether that may have been in Asia or in Africa.

# The Inquiry into the Abrams "Dynamiser" and Similar Apparatus.

*The finding of Sir Thomas Horder's committee that phenomena of some kind are produced by apparatus of this nature has aroused interest. The effects produced are, however, not necessarily curative or helpful in diagnosis and do not justify the wide claims made for the new "treatment." Investigations are still in progress.*

"Starve, ache, burn, smother
Father, father, mother, mother
Smite, smite, smote, smitten
Cub, calf, kitten."

THERE was a phrase in the days of Rome which said that there was always something new from Africa. To-day we might say the same of America, but with a difference. From Africa there came Hannibal's elephants, looking, as G. K. Chesterton said, as if they didn't exist. Yet they did exist, these first-recorded "tanks." From America we get the new poetry—such as that of which we quote a specimen above; from America we get the spiritualist in his most developed form; and America bore Abrams. And, to pervert a famous saying, the new world has been called in to upset the balance of the old. Is the new poetry really poetry? Are there really ghosts? And has Abrams revolutionized medicine?

**Belated Analysis.**

Of course, we get American crazes, like American plays, a few years late. Wireless and cross-word puzzles were stale in the U.S.A. before we even heard of them. We tend to lag. And that explains why, though the electronic reaction of Abrams was devised by that graduate of Heidelberg in 1916, and discredited in America two years ago, it is only to-day that one of our most eminent physicians has been induced to be at one and the same time sparklingly witty at its expense and yet, apparently, ready to lend the weight of his reputation to uphold some aspects of it. If there be anything at all in this new discovery, then Sir Thomas Horder must live in the history of medicine as the man who had the insight and the courage to pluck from what is admittedly a tangle of wilful deception and crass ignorance a nucleus of valuable truth. If there is not, one is left yet again with the spectacle of another scientist who, as was the case with Sir William Crookes, found ascertainable knowledge inadequate, and followed the will-o'-the wisp of conjecture, to become the prey of conscious or unconscious fraud.

Abrams' career was interesting, but does not here concern us. With much which is worthy of note in this context, it is recorded in *The Scientific American*, which first conducted a thorough investigation of Abrams' work. Abrams is now dead; it is a pity: no one, it is certain, would or could have better appreciated the late surprising developments in his original schemes and designs. Even so does one regret that Jules Verne never saw a submarine or an aeroplane, or that Baron Munchausen—if we accept another point of view—never saw his name quoted beside Thucydides as an authority.

Before he died he started two movements. One was a school of "Spondylotherapists," who cured everything, and indeed still do. He later invented two machines. One was an oscilloclast; this cures people. The other was a dynamiser; this diagnoses. It diagnosed, in his hands, not only your disease; from a drop of your blood it could diagnose your age, sex, religion, and handicap at golf. In the hands of a committee of investigation, of which Sir Thomas Horder was a member, it diagnosed the difference between a bottle which contained sulphur and one which did not.

Now, simultaneously with Sir Thomas Horder's report on the dynamiser—we will say more of that in a moment—there comes a book by Dr. G. Laughton Scott on the oscilloclast. Both these authorities speak at least deferentially of their instrument. But there is one significant feature. Both of them emphatically repudiate any belief in the other instrument.

**The Two Instruments.**

Sir Thomas Horder says "No attention whatever has been paid to the oscilloclast." Dr. Laughton Scott, is is true, has an ominous foot-note to the effect that sweeping criticisms of the dynamiser are premature. But he is concerned alone with the instrument which cures. This point is worthy of deep consideration.

Two years ago, as we have said, *The Scientific American* concluded its investigation of the Abrams methods. Abrams himself proved elusive; he never met the committee of inquiry. Some of his disciples did. They were asked to identify bacterial cultures with his "dynamiser." They were all wrong; yet

any bacteriologist can and does identify these by sight daily, with fair accuracy. They failed to diagnose carious teeth ; they even diagnosed as well—or as ill—when the precious drop of blood was in the instrument as when it was not. *The Scientific American*, in short, reported that the electronic reactions of Abrams did not exist.

Now for Sir Thomas Horder's committee. It consisted of Dr. C. B. Heald, Medical Adviser to the Director of Civil Aviation, Major H. P. T. Lefroy, a wireless expert, and Messrs. M. D. Hart and Whateley Smith, experts in physical research for the Air Ministry and War Office respectively. One confesses to a slight feeling of confusion as to the peculiar fitness of some of these experts for their task. But at least one later addition must seem peculiarly apt ; this was Mr. E. J. Dingwall, M.A., an expert on ghosts real and artificial. He was research officer to the Society for Psychical Research. He found no trace of trickery in the researches which Sir Thomas Horder reported. Normally, doubtless, he would have presumed ghosts as the cause of the strange happenings, though we admit that is only our assumption. On this occasion, it appears, " science," not ghosts, must explain them.

In the beginning, one must admit, Sir Thomas Horder's investigators met with failure. The dynamiser, one should know, is connected with a specimen—blood, a bottle of sulphur or what not, and a human being : any human being—in this case, a Glasgow boy. The boy is just part of the instrument. The observer puts his hand on the boy, percusses him—strange how primitive yet impressive processes such as percussion come into this new method—and by a difference in the percussion perceptible only to the observer he makes his diagnosis. Note that Mr. H. St. G. Anson, an expert from Faraday House, was quite unable to detect by physical, electrical means any change. The observer tapping the Glasgow boy alone found the difference.

### Far Too Wrong.

At first, as we have said, the observer failed pitiably. But more than that, as Sir Thomas Horder said, with pride, he failed egregiously. He was far more wrong than he could possibly have been if something had not been putting him wrong. He was nearly always wrong. Chance could not explain that, he said. How one wishes one had thought of such reasoning at school when some malign fate, possibly the electronic reactions of Abrams, almost invariably made us go wrong !

But then there came a change. Either a better brand of Glasgow boy, or " better screening " or something came into the proceedings. Twenty-five successive attempts to differentiate two apparently identical bottles, which the observer could not see, were correct. The chances against this happening by accident are one in 33,554,432.

In between his observations, we are told, the observer washed his hands.

Let us change the scene a little. The present writer, some years ago, in Cambridge, in a room of forty people, induced each individual in succession to take one out of five cards from his hand, without error. He had no dynamiser at hand. He has no conception as to how he did it. All he knows is that such a thing is not only possible, but almost certain, given, it appears, the correct emotional atmosphere.

### Try This Yourself.

It can be done by nearly everyone ; let any reader of this article try the test. Take five cards ; spread them fan-wise. Select one of these cards, concentrate your attention on it. Take your subject's right hand in yours ; tell him firmly to take, without delay or hesitation, that card. He, of course, does not know where it is ; it is best to ask him to close his eyes, while a third person points to the card to be chosen. Look your subject straight in the eyes ; do not glance at the card, or move the hand holding the cards ; try to avoid any indication as to its position. We prophesy, with confidence, given only the correct emotional atmosphere, a result rivalling that of Sir Thomas Horder s committee. And you need not necessarily wash your hands.

Sir Thomas Horder has not said that the dynamiser is of any value in medicine. He thinks it has none, one gathers. But he thinks his committee has proved that something does happen with that instrument. There are two other possibilities : fraud, conscious or unconscious, or that strange influence which we can refer to as the five-card trick.

Then there is Dr. Scott's book. Let us begin by emphasizing our confidence in the absolute honesty of the writer. He believes that the oscilloclast can cure. He quotes cases ; his book consists entirely of cases. That is the only reasonable way to prove his own case. But the difficulty, of course, is to know how many cases to take. Moreover, one wants to know how many cases failed. One knows them with regard to his own cases. He frankly tells us that lots of them failed. He quotes in detail nine cases. They appear to have progressed much as any nine cases, taken at random from a consultant's note-book, might have been expected to progress. Cases of pernicious anaemia and acute heart disease died. A case of

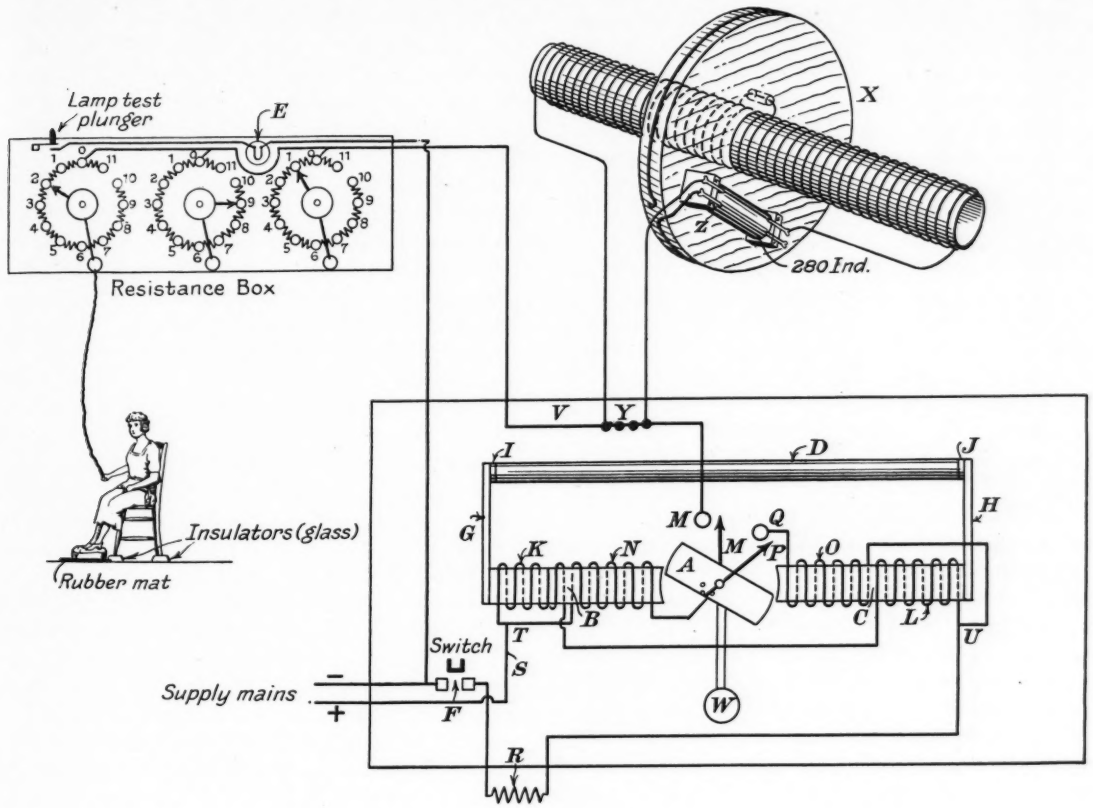



FIG. 1.
THE OSCILLOCLAST.
(Diagram from "The Abrams Treatment in Practice," by G. Laughton Scott, M.R.C.S.)
This has an oscillating—not a rotary—armature *A*, making and breaking circuit 98 times per minute at *M*, which allows a slight leakage from one of the main current leads to pass through the resistance box to the subject.

generalised tuberculosis, operated on, improved. Other cases of tuberculosis went on slowly, apparently recovering. And so on—the daily round, the common task of the doctor, varied only by the presence in the background of the oscilloclast.

### Cases Recorded.

One is not so certain as regards the proportion of improvements among the cases he records on hearsay evidence. Three medical men provided him with his evidence. Only about sixty cases in all, which were of many different types, suffering from diseases as different as syphilis and cancer, are given. And almost the only failures quoted are the author's own. Moreover, they are nearly all cases of chronic diseases running, normally, an up and down course, such as tuberculosis and arthritis. And any volume of any medical periodical can and does show similar claims, though usually supported by a very much longer list of cases in support of new cures.

We must make mention, however, of the cases of cancer recorded. We feel very strongly that no mention should have been made of a disease whose sole hope of cure is early operation, unless claims with regard to a new treatment were supported by a series of many more cases, much more strictly diagnosed, and watched for a far longer time than has been the case in this instance. Some of the cases have not even at the time of writing survived the twenty-eight months which is the normal span of life of untreated cancer of the type mentioned.

### Value of Mystery.

We have given, so far, an admittedly inadequate account of recent developments in a very highly commercialized form of treatment and diagnosis which has been carried on for nearly nine years both here and in America. There are, however, one or two further features in this connexion which should be stressed. In the first place, Abrams himself

charged £150 for his instrument; in the second place those who used the instrument were pledged never to examine it in any way. An old, old story, this. The mysteriousness of the cure is the secret of the fortunes of proprietors of patent medicines. And one thing, it seems, all investigators agree upon.

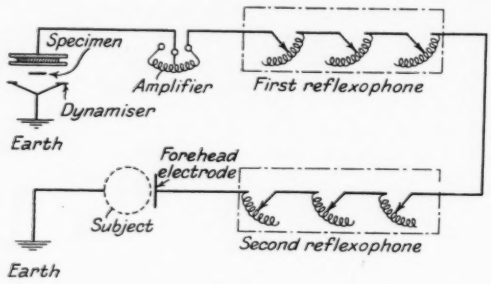



FIG. 2.
ABRAMS DYNAMISER CIRCUIT.

If there is anything whatever in Abrams' methods, it is purely an accident, and no one would have been more surprised than Abrams. Four shillings has been suggested as a reasonable price for his £150 instrument. For someone, somewhere, has proved untrue to his trust, and dared to pierce the secrets of the magic box.

The second half of Dr. Laughton Scott's book is occupied by a report by two electrical engineers on the oscilloclast. They begin by saying that "We are of opinion that no consistent, trustworthy or physically and logically explainable results can be obtained [by the dynamiser]." They admit that they did not examine that instrument, but their opinion is of some interest, all the same.

They did examine the oscilloclast, and our illustration shows the wiring diagram. In the first place, it contains an induction coil on an open circuit, which can have no possible function. (American observers, we may add, found no less than three independent closed circuits on one of Abrams' oscilloclasts.) But, in the second place, they found that when a patient was attached to the oscilloclast, he was submitted to a definite, but very inconsiderable, electrical experience. That experience, say the investigators, could be obtained by far more simple apparatus; what happens is that the patient receives a definite charge of electricity about two hundred times every minute, and the potential of that charge equals that of the supply main to which the apparatus is connected.

Without going into details, a glance at the illustration will give a sufficient idea as to how the instrument works. It is obviously in three parts. That marked *X* is the portion which is useless according to these investigators. Below this is a pendulum contact-maker and breaker, marked *W*, which makes connexion about two hundred times a minute between the patient in the chair and the electric supply main. A series of resistances complete the apparatus, and these are shown on the left.

If the insulation of the patient were perfect, the first charge alone would affect him. Actually there is a constant small leak through the air and the glass insulators on which he sits. Hence the patient is submitted to a series of charges and discharges.

Abrams himself believed that there was a certain "periodicity" peculiar to each disease, and that by adjusting his pendulum rate to this periodicity he could in some way influence the disease. Dr. Scott says nothing of this; he offers no explanation of the method by which he claims to cure.

The other illustration is of the actual apparatus which Abrams used as a diagnostic method—the "dynamiser"—and also of the adaptation of this instrument used by Sir Thomas Horder's committee. We take the following description of it from the *British Medical Journal's* correspondence columns:—

"Looking at the sketch of Abrams' apparatus, given by Sir Thomas Horder, I find in it (1) an earth connexion on the left hand; then (2) some kind of support for holding the blotting paper specimen called a dynamiser; then( 3) a variable resistance coil called an amplifier, but it amplifies nothing; (4) two step-by-step resistance coils called reflexophones; (5) a boy or subject, who has an electrode on his forehead, and his feet apparently on an earth-plate. In other words, there is a living subject with his head and feet connected through variable resistances with the specimen.

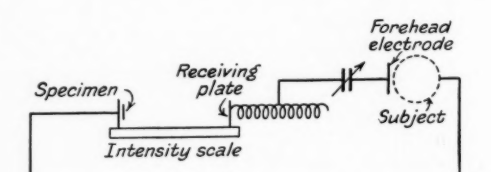



FIG. 3.
DR. BOYD'S MODIFICATION OF ABRAMS' DYNAMISER
with which Sir Thomas Horder's committee carried out their investigation.

We can only hope that the publicity which Abrams' magic box has gained may, in the long run, induce too precipitous enthusiasts to return to the common round and trivial task of orthodox, unmysterious science.

# The Psychology of Fashion.

By F. A. Hampton.

*What is the basis of fashion? Is it purely a herd movement following an example set by upper-class innovators, or is it a general mass reaction against the tastes of a preceding generation? The adoption of a new fashion or the modified revival of an old one may represent a change of taste or opinion in a majority and an attempt to stabilize new views.*

THE first thing that comes to the mind when we think about fashions is the general complaint against their tyranny, and a general lamentation for the weakness that submits to it.

If we seek the reason for the sway of fashion we usually find it ascribed to a tendency innate in man which urges him to behave in the same way as his fellows. But it is difficult to discover this tendency in the psychology of the individual, whose ideal seems to lie in the direction of differentiating himself from his fellows rather than in imitating them. The tendency to imitation seems to be imposed from without, and to spring from the hostility of the herd to any member of it who asserts his independence by departing from the customs of his group. This hostility is necessary, since the strength and value of the herd depend upon its uniformity, a quality insisted upon in the army, that typically strong herd, and expressed in its peculiar use of the word "uniform." We may recall, in this connexion, a divisional order issued in France at the end of 1914 which directed that "the practice of wearing coloured stocks shall be discontinued forthwith." We can detect the hostile herd feeling in our own attitude towards any one of our fellows who deliberately departs, in clothing, mode of speech, or even opinions, from the type common to our group, and it is reasonable to suppose that we imitate one another not from any pleasure that we get in so doing, but in order to avoid hostility and estrangement.

### Imitative Flattery.

Deliberate imitation is also an occasional and obvious motive for following a fashion. It is expensive to discard old habits for new ones, so that change of fashion is chiefly the prerogative of rich and powerful groups. But, once the change has been effected, demand facilitates the supply, and the new modes, becoming generally available, are taken on by less wealthy individuals who are seeking to identify themselves with the more favoured groups. Thus fashions tend to spread downwards in society. But not invariably; for the leisured classes are liable to drift out of touch with reality and, from time to time, try to recover contact, if only in make-believe, by assuming the fashions of the workers, and they play at being shepherd and shepherdess, knot costers' handkerchiefs round their necks, or disguise themselves as Tyrolese peasants.

This tendency to supply, in symbol or phantasy, what we feel to be lacking in our surroundings, is a general principle that has a strong influence upon fashions, and is, perhaps, the factor that ultimately determines their form.

### Jealousy of Invaders.

A simple example is the Wild West in film and story, and (in another plane of society), the picaresque novel, which supply an obvious want, created by civilization, and almost coexistent with it. A more specialized demand is supplied by the "Sheik" novel, with its theme of the humiliation of a woman by a brutal lover, which presumably gratifies that innate tendency in woman to submission which is incompatible with her present position of independence.

We have seen, in a general way, that a fashion serves by its uniformity to bind the herd together. This important function is evident in small groups where the fashion serves, most distinctly, as a sign by which members of the group recognize one another and acknowledge their common interests. As a distinctive herd-mark the fashion is kept jealously by the group in which it arose, and its use by outsiders is, consciously or unconsciously, resented. We see this function in the fashion of slang, for while we do not mind if a foreigner speaks our language correctly (though we are predisposed in his favour by occasional lapses), we feel a slight irritation if he attempts to use our slang, when he appears to us as an intruder trying to pass himself off as one of our group. It is not only foreigners who evoke this feeling, for slang is the most delicate test of group membership, and no shibboleth is more difficult to imitate. A special piece of slang will often spread, on its own merits, outside the group in which it arose. It then loses its value as a herd-mark, and its inventors forthwith replace it. This process was clearly seen during the war, when the slang words of the fighting troops were

dropped by them as soon as they found their way into the press. The argot of the fighting man was taken up very readily at home and, in consequence, the slang of the front line was constantly changing, so that is was possible, when a man was on his way back to the line, to make a rough guess from his conversation at the length of time he had been away.

### New Ideas, New Values.

So far we have considered chiefly the limited and short-lived fashions, but there is a deeper and more lasting kind of fashion that we can usually detect as a common factor running through all contemporary fashions. This common factor is a reflection of the collective attitude of the people, and a fashion cannot succeed unless it is in harmony with the collective attitude and satisfies the unconscious demand. The fashion-makers have discovered that the public cannot be made to accept a fashion that it does not want, though it may not know what it wants until it sees it. It is the driving force of the collective tendency that, at bottom, gives the fashion its power of compelling obedience.

An example of this common factor in fashions was given a few days ago by, I believe, Mr. Hind, who correlated Professor Bergson's philosophy (which became almost instantly fashionable in Paris) with the ideals expressed by M. Bakst in the Russian ballet, to which we might add jazz music, Fair Isle jumpers, Shaw's " Back to Methuselah," and, generally, a strong predilection for the exotic. From these fashions we might deduce that the present collective attitude is one of transition in which the old lines of thought and the old harmonies are being discarded, while a serious attempt is being made to link new ideas and new values, which are often apparently unrelated or even discordant, into one synthetic whole. There seems to be a tendency to go back to primitive, simple elements for the materials of the new synthesis and to reject the blended and the compromise. For this, essentially Bergsonian, attitude the jazz tune and the Fair Isle jumper are not altogether inadequate symbols, and even the crossword puzzle and the acrostic are not irrelevant.

The collective attitude, of which fashions are the expression, seems liable to a regular periodic change, which is apparently due to a tendency of the children to react, when they grow up, against the taste of their parents. We find an example of this periodicity in the art and literature of the eighteen-nineties, when a reaction replaced the early Victorian preoccupation with moral values by a preoccupation with sensation, and robust colouring and solid decoration gave way to flimsy hangings and subdued indeterminate colours. The next phase has now set in, and the present generation has no taste for the soft colours, curiously called " art shades," that pleased its parents; magenta has no personal associations with Victorian family life, and is no longer proscribed. It is significant that in the most solidly popular novelist of our day, Joseph Conrad, we find a steady insistence on a moral value, that of loyalty. These reactions are not simply a reversion to the taste of our grandfathers, for in so far as the old fashions return they do so with a difference. The use of magenta and emerald green is modified by Chinese influence. Formality is returning to our gardens, not as Victorian carpet-bedding, but in the style of the 17th century. The moral values of Conrad and the later Shaw are not idealistic or religious like those of the Victorians, but deduced directly from experience.

The collective attitude is apparently subject to another and more obscure periodicity, which shows itself in phases of formalism and regularity alternating with shorter phases of free expression and irregularity. This may be due to the periodic breaking-up and re-formation of the herd, which seems necessary for the adaptation of society to changing conditions. Free and individual expression gradually becomes formularized under the influence of the herd which, as we have seen, tends to impose uniformity, and the formulae, once they are established, are maintained by that conservatism upon which the stability of the herd partly depends. The formulae are liable to retain their hold long after they have ceased to reflect accurately the opinions and taste of the majority, so that the end of a period of formalism is usually marked by the sporadic formation of new groups, and the next phase of irregularity and licence is sometimes born in revolution.

### Fashion and Politics.

It is not easy to distinguish the influence upon fashions of this periodicity from the other that is due to succeeding generations, but a periodic dislike of the straight line in design and architecture may be the expression of a protest against formalism. We find it in the landscape gardening of the eighteenth century, when Capability Brown discovered that nature abhorred a straight line, and the avenues and formal gardens of those who could afford the change were swept away to be replaced by idealized natural landscapes. This change of taste may be correlated with the contemporary opinions of Rousseau and others which were leading up to the French revolution.

It appeared again in the popularity of rock gardening and wild gardening which set in towards the end of the twentieth century. The curious wrigglings of "l'art nouveau" in furniture and decoration may be taken as another reaction against the straight line that was too emphatic to be long-lived.

There seem to be faint indications that the straight line is returning to popularity. We see it appearing in architecture and in furniture design, while in the garden there is a distinct return to formality and crazy pavement is giving place to squared. If these are real tendencies we may be justified in drawing the inference, cautiously, that a period of licence and experiment is drawing to a close, that the synthesis referred to earlier is being accomplished, and that a period of stability is approaching.

## Books Received.

*Living Organisms.* EDWIN S. GOODRICH, F.R.S. (Oxford at the Clarendon Press. 6*s.* net).

*The Effects of Posture and Rest in Muscular Work.* (H.M. Stationery Office. 2*s.* 6*d.* net).

*Great Peoples of the Ancient World.* D. M. VAUGHAN, M.A. (Longmans, Green & Co. 3*s.* 6*d.*).

*Crop-Production in India.* ALBERT HOWARD, C.I.E., M.A. (Oxford University Press. 10*s.* 6*d.* net).

*The Pipe Book.* ALFRED DUNHILL. (A. & C. Black Ltd. 18*s.* net).

*Local Geography.* C. G. BEASLEY, B.A., F.R.G.S., etc. (Thomas Murby & Co. 1*s.* 6*d.* net).

*Organic Medicaments and their Preparation.* ERNEST FOURNEAU. (J. & A. Churchill. 15*s.* net).

*Annuaire pour l'An* 1925. Publie par le bureau des longitudes. (Gauthiers-Villars et Cie. 650*fr.*).

*The New Past and other Essays on the Development of Civilization.* Edited by E. H. CARTER, M.A. (Oxford: Basil Blackwell. 5*s.* net).

*The Geographical Journal.* Vol. LXV. No. 1. Jan. 1925. (Royal Geographical Society. 2*s.*).

*Annual Report of the Working of the Museum Department during* 1923-1924. By the CURATOR, Valletta Museum.

*The New Decalogue of Science.* ALBERT EDWARD WIGGAM. (J. M. Dent & Sons. 7*s.* 6*d.* net).

*Telepathy and Clairvoyance.* RUDOLF TISCHNER. (Kegan Paul. 10*s.* 6*d.* net).

*Concerning the Nature of Things.* SIR WILLIAM BRAGG, K.B.E., D.Sc., F.R.S. (G. Bell & Sons. 7*s.* 6*d.* net).

*An Introduction to the Literature of Chemistry.* F. A. MASON, M.A., Ph.D., F.I.C. (Oxford at the Clarendon Press. 2*s.* net).

*Sunlight.* Vol. I. No. 1. December 1924. (The Sunlight League. 1*s.*).

*Annual Report of the Smithsonian Institute.* 1922.

*The Pre-Tertiary Geology of Mull, Loch Aline and Oban.* G. W. LEE, D.Sc., and E. B. BAILEY, M.C., B.A. (H.M Stationery Office. 4*s.* 6*d.* net).

*Callinicus: A Defence of Chemical Warfare.* J. B. S. HALDANE. (Kegan Paul. 2*s.* 6*d.* net).

*Sex and Civilization.* PAUL BOUSFIELD, M.R.C.S., L.R.C.P. (Kegan Paul. 10*s.* 6*d.* net).

*The Mentality of Apes.* PROF. W. KÖHLER. (Kegan Paul. 16*s.* net).

*The Subject Index to Periodicals.* 1921. G—Fine Arts and Archaeology. (The Library Association. 9*s.* net).

*The Australian Journal of Experimental Biology and Medical Science.* Vol. I. Part 4. (University of Adelaide. £1 1*s.* per annum, issued quarterly).

*Psyche.* Vol. V. No. 3. January 1925. (Kegan Paul. 5*s.*).

*Junior Technical Electricity.* ROBT. W. HUTCHINSON, M.Sc., A.M.I.E.E. (University Tutorial Press. 4*s.* 6*d.*).

*A History of Sculpture.* GEORGE HENRY CHASE and CHANDLER RATHFON POST. (Harper & Bros. 16*s.* net).

*Helmholtz's Treatise on Physiological Optics.* Edited by JAMES P. C. SOUTHALL. Vol. II. The Sensations of Vision. (The Optical Society of America. $7).

*Cancer and Remedial Diet.* H. REINHEIMER. (Grevett & Co. 2*s.* 6*d.* net).

*Optical Measuring Instruments.* L. C. MARTIN, F.R.A.S., D.Sc., A.R.C.S., D.I.C. (Blackie & Son Ltd. 17*s.* 6*d.* net).

*Louis Pasteur.* S. J. HOLMES, Ph.D. (Chapman & Hall. 7*s.* 6*d.* net).

*The Psychology of Religious Mysticism.* JAMES H. LEUBA. (Kegan Paul. 15*s.* net).

*The Psychology of Emotion.* JOHN T. MACCURDY, M.D. (Kegan Paul. 25*s.* net).

*Nature Studies of a Boy Naturalist.* C. T. ASTLEY MABERLY. (T. Fisher Unwin Ltd. 6*s.*).

*Scientific Papers, mainly on Electrodynamics and Natural Radiation.* By the late S. B. MCLAREN. (Cambridge University Press. 8*s.* 6*d.* net).

*Rejuvenation By Grafting.* DR. SERGE VORONOFF. (George Allen & Unwin Ltd. 15*s.* net).

*The Tyranny of Time: Einstein or Bergson?* CHARLES NORDMANN. (T. Fisher Unwin Ltd. 10*s.* 6*d.* net).

*Outlines of General Zoology.* H. HACKETT NEWMAN. (Macmillan & Co. 16*s.* net).

*The Psychology of a Musical Prodigy.* G. RÉVÉSZ. (Kegan Paul. 10*s.* 6*d.* net).

*Aspects of Science.* H. SPENCER TOY, B.Sc., etc. (Dranes. 6*s.* net).

*Burton the Anatomist.* Edited by G. C. F. MEAD and R. C. CLIFT. (Methuen & Co. 5*s.* net).

*Physico-Chemical Evolution.* CHARLES E. GUYE. (Methuen & Co. 6*s.* net).

*Textbook of General Botany.* RICHARD M. HOLMAN and WILFRED W. ROBBINS. (Chapman & Hall. 20*s.* net).

*Principles of Human Geography.* ELSWORTH HUNTINGTON and SUMNER W. CUSHING. (Chapman & Hall. 15*s.* net).

*Lamarck-Darwinism and Dental Disease.* ORAN STARR, D.D.S., L.D.S. (Routledge & Sons. 21*s.* net).

*Radio: Beam and Broadcast.* A. H. MORSE, A.M.I.E.E. (Ernest Benn Ltd. 12*s.* 6*d.* net).

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LECTURERS and instructors in technical subjects will appreciate the usefulness of lantern slides which cover almost the entire range of natural history, including biology in all its branches, physics, geology, astronomy and other fields of scientific inquiry. These can be obtained from Flatters & Garnett Ltd., 309 Oxford Road, Manchester. The slides are of standard English size, but other sizes can be supplied if required. A comprehensive catalogue issued by this firm gives full details.

# Book Reviews.

*Living Organisms : An Account of their Origin and Evolution.* PROFESSOR S. GOODRICH, F.R.S. (Clarendon Press. 6*s.* net).

Professor Goodrich's new book is an admirable introduction to evolutionary biology. It is the only introduction to evolutionary problems of its scope which is written from an essentially modern standpoint. The author expresses the hope that it will prove a useful guide not only for the scientific student, but also for the general reader. As such it can be warmly commended to readers of *Discovery*.

In one sense Professor Goodrich is not modern. He has the tough-minded attitude towards biological phenomena which was far more characteristic of the Victorian epoch. We live unhappily in a more comprising age. Many zoologists trained in a school which did not recognize energetics as part of its curriculum, confused by exponential functions and bewildered by buffer solutions, look back with longing to Lamarck and "Les Philosophes" or seek comfort in the atavistic crudities of M. Henri Bergson. Against this recrudescence of animism Professor Goodrich remains steadfast in the robust rationalism of the elder Huxley :

"As the untutored savage explains the movements of a watch by attributing them to a spirit which has entered into it, so many writers hold that the activities of living matter are due to some special and mysterious vital force. They attempt to bridge the gaps in our knowledge by merely giving them a name. This is no scientific method ; science advances by explaining, that is describing, the unknown in terms of the known. If vital force is merely a general term for those new properties manifested in new mechanisms of increasing complexity, there is no harm in it ; certainly living matter must display properties not found in simpler substances. But it has no intelligible meaning, if used to denote some force added, so to speak, from without over and above the ordinary properties, some force acting on the physico-chemical mechanism but not of it."

Of most of the chapters there is nothing to be said by way of criticism ; they are lucidly and tersely written ; packed with the right sort of information, and replete with thought-provoking considerations bearing on formal statement of conclusions to be drawn from modern experimental work. The remarks on pp. 62, 83, 90-91 might be read with profit by many professional zoologists. Given a selection of what the expert is entitled to regard as the most significant data, the intelligent student should be expected and encouraged to exercise his own gene-given reasoning powers. It is difficult to comprehend why so many men of science in writing popular or elementary books seem to imagine that to be interesting it is only necessary to be vague. Perhaps the most striking quality which distinguishes Professor Goodrich as a popular writer—another of the Victorian virtues—is the fact that he does not regard superficiality as a necessary concomitant of simplicity.

If there are any criticisms to be made of this admirable work, they concern minor issues. One may, without impertinence, express the hope that on p. 28 et seq. the author will in future editions make use of Dobell's distinction—adopted in Doncaster's cytology—between cellular and non-cellular (instead of uni- and multi-cellular) organisms. Also one may join issue with Professor Goodrich in his excess of loyalty to Darwin's memory. Is it not time that we dropped the term *Darwinism*, so redolent of associations of that atmosphere of thought from which it emerged, and surely more appropriate to a new faith than to a scientific hypothesis ? One thinks of Mohammedanism, Wesleyanism, Pelmanism . . . ; and is not this very excess of loyalty a cause of the reaction against Darwin which the author deplores ? One has to turn to the controversies of the late nineteenth century to get a truer perspective of Darwin's influence than can be obtained by scrutinising isolated sentences from "The Origin of Species" in the sophisticated light of Drosophilology. After all, Darwin's view of Natural Selection was not identical with the modernized and unexceptionable statements on p. 103 and those pages which follow. Though his immediate followers idolized the doctrine which came to be known as pan-mixia far more than did Darwin himself, there is plenty of evidence that to Darwin dilution of characters by crossing was the crux of the whole matter. However highly we may place Darwin's individual contribution our business is not to lay flowers before the shrine, but to carry forward the torch of scientific inquiry. "If history is to repeat itself" writes Tylor, in concluding his account of primitive culture, "we must look forward to stiffer, duller ages of traditionalists and commentators when the great thinkers of our time will be appealed to as authorities by men who slavishly accept their tenets yet cannot or dare not follow their methods through better evidence to higher ends." Not everyone who saith Lord, Lord, shall inherit the kingdom of scientific truth.

LANCELOT HOGBEN.

*Optical Measuring Instruments.* By L. C. MARTIN, F.R.A.S., D.Sc. (Blackie & Son. 17*s.* 6*d.* net).

This will be a very welcome book not only to the teacher of science but to the worker who for any purpose has to use optical measuring instruments. The ordinary textbook gives at the best but rough guidance and often problems are encountered in special research which require the fine use of unfamiliar tools. It is in this sense that Dr. Martin's chapters on measuring and micrometer microscopes are in themselves one of the most valuable features in the book. They give precise guidance and say where mechanical errors are likely to be found and what methods may be employed to discount them.

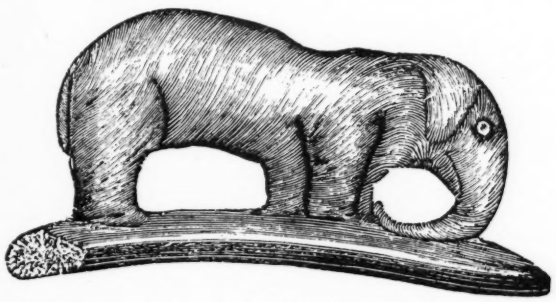
The book in general covers the whole field of optical measuring instruments, such as photometers, polarimeters and saccharometers, spectrometers, theodolites and range-finders. The section devoted to the latter is remarkable for the very clear description of the optical principles involved in most of the familiar types. The Zeiss stereoscopic model, in which the distance readings on scaled graticules in the focal planes of the eyepiece lenses are apparently projected over the field of view so that the range of a distant object can be instantly read off, is very clearly explained. The advantage of this instantaneous reading without the delay necessary to the adjustment of a coincidence range-finder is very important when ranges are being taken on rapidly vanishing objects such as the smoke of shell-bursts, but the author notes that the stereoscopic sense is widely different in individuals.

There is much sound constructive criticism of the mechanical design of existing instruments, and the optical manufacturer may find many suggestions of value to him for the book is written from the point of view of the user of the apparatus described. The author, however, states in his preface, "It may be noted in passing that the practice of many of our British firms is second to none," an acknowledgement of merit with which we heartily agree.

*The Pipe Book.* By ALFRED DUNHILL. (A. & C. Black, Ltd. 18s. net,).

A little reflection on the subject of pipes and tobacco in history makes one wonder what King James the First, who held "that tobacco was the lively image and pattern of hell," would say to Mr. Baldwin. Perhaps the discussion would not be so acrimonious as we might think, for even in his day James applied the wicked import duty of six shillings and tenpence a pound. The three intervening centuries of every kind of hard-won liberty and scientific progress find us with tobacco once again at much the same expensive price. But the pipe is an emblem of peace rather than revolution and there is no cause to fear tumults. Money is cheaper and tobacco too, is probably better, for in those days we find Armin (1608) writing in his "Nest of Ninnies" of "tobacco sophisticated to taste strong," and learn of another contemporary writer that: "they sophisticate and farde the same in sundrie sortes, with black spice, galanga, aqua vitae, Spanish wine, anise seedes, oyle of spicke, and such like." The trick is still played I believe with cigarettes for ladies' smoking, but the pipe smoker cherishing his pipe avoids the poisoned bowl.

Mr. Dunhill's book does not deal with the delicate subject of tobacco, but only with pipes ancient and modern, savage and civilized, smokeable and unsmokable, great and small, in fact, with every kind of pipe except organ pipes and gas pipes and if anyone had ever smoked an organ pipe doubtless it would have been included.



It is a matter for regret that something, probably a fine sense of commercial modesty or perhaps some little affair of trade secrecy, has prevented the author from giving us a few hints on how to nurse, doctor, and restore a meerschaum which colours unevenly, shows finger-marks and generally behaves as meerschaums do behave. Personally, I do not like a meerschaum. It is to me a frail unhandy thing with a faint bouquet of that vanished convenience the wax-vesta about it. I did, however, want to know if there was any way of treating an old old pipe which, despite much cleaning, had grown too seasoned to be a pleasant companion in fastidious society. These matters of importance to the owner-smoker are, however, omitted.

Another omission is the corrugated acid-etched or sand-blasted pipe—those mysterious gnarled grotesques which were the vogue among newly-recruited pipe-smokers a year or two back. I always doubted them, deeming it a device of the pipe-maker enabling him to foist off on the public wood which otherwise would not bear critical scrutiny. I remember one too, whose mellow antique finish gave off a rich copying-ink coloured dye in wet trenches. The owner on his next leave returned it to thevend or who said with some sense of injury: "Ah, sir! but I can see that you have been smoking this pipe out of doors!"

The curious will find in this book a wonderful record of pipes collected from all parts of the world and nearly all tribes and peoples. The Eskimo pipes of walrus ivory are among the most interesting, and the Indian pipes dug up in the mounds of the northern United States perhaps the most valuable from the point of view of the ethnologist and archaeologist.

There is, too, something of a mystery about these pipes, for while ethnologists take sides in the conflict of opinion about the copan steles where an elephant-trunked beast is variously claimed to be (1) a traditional Asiatic elephant, (2) a tapir, (3) a great hornbill, there are, or were, in existence certain stone pipes made by Red Indians in the likeness of mammoths or mastodons. One of these mammoth pipes was dug up on 10th January, 1877, by the Davenport Academy of Natural Science, at Iowa. We reproduce the illustration from page 653 of "Man and his Handiwork," by the Rev. T. G. Wood, S.P.C.K., 1886.

In view of the interest in the copan steles and the trouble Professor G. Elliot Smith has taken to convince people that it is an elephant, and probably Asiatic at that, this reminder about another kind of proboscidian carved out by Indians in America may be timely. Nearly fifty years have passed since these pipes were found, and both archaeological and ethnological knowledge have made great strides. It is now possible that a more accurate estimate of their age can be formed.

Dunhill's book can be commended for casual reading, and a foreword bids critics to disarm. There are neither footnotes, references, nor a bibliography, but plenty of illustrations.

*The New Decalogue of Science.* By ALBERT EDWARD WIGGAM. (Dent. 7*s.* 6*d.* net).

Mr. Wiggam throws a brick, a good massive uncouth mixed-up brickbat through the windows of laboratories, cathedrals and studios alike. It is the kind of book one cannot help but call stimulating. It is like a pocket Walt Whitman trumpeting undigested biology, eugenics, psychology, and general mixed noises.

A short but incandescent correspondence with Mr. Bernard Shaw removes a good deal of the prophet's mantle from the enthusiastic Mr. Wiggam. Shaw, writing of one of Mr. Wiggam's articles, expressing the same enthusiasm and loose thinking, says, "I can only say that you have made the most fearful mess of the job." Without agreeing with much of Mr. Shaw's philosophy, we heartily agree with his view of Wiggam's book, but congratulate Wiggam on drawing G. B. S.

Nevertheless, although Wiggam as a whole puts up a catastrophic mass of loose thinking, angles of his brickbat are worth noting. We like the nerve of the man who tells us that medicine, hygiene, and sanitation will weaken the human race, that morals, education, art and religion will not improve the human race, and goes on to advocate rather than to prove that the solution lies in the application of science to politics. Mr. Wiggam we fear ignores the fact that the ordinary man can endure politicians, but with wisdom dreads professors when these latter are translated to positions outside academic circles.

Still, the book is written for America, and that is a country which needs light. "Lying on my desk," says Mr. Wiggam, "are three letters from city school superintendents thrown out of their positions within the past five months by public vote because they believed that all men, even Mr. Bryan, are related to monkeys."

Without going into details of ethnology we confess that the obligatory enforcement of a belief in the Book of Genesis is a trifle reactionary and that Mr. Wiggam's ideas may do good in America. So far as British thought is concerned Mr. Wiggam's views appear to be of little value; in fact, to borrow one of his national aphorisms – raw stuff.

*Modern Astrophysics.* By PROFESSOR HERBERT DINGLE. (W. Collins & Sons. 30*s.* net).

Astrophysics is now, so to speak, a fully-grown science on its own and not to be confused with astronomy. It is a remarkably difficult subject to tackle from the standpoint of producing a reasonable non-mathematical book which can be followed by the lay mind and this in itself explains the anomaly of a popular handbook which develops into a weighty volume.

Professor Dingle has, we think, succeeded in accomplishing his task. He has made a good deal more than the elements of astrophysics clear to the lay mind and, indeed, covers almost the whole vast subject, leading his readers perhaps further than their capacity.

It is a peculiarity that, although mathematics are specifically excluded, one senses them as uneasy ghosts always bobbing up and down behind the facts, and the subject is one that will still baffle the layman or at least fail to hold his interest unless he has a mathematical habit of mind. In this way it is perhaps hardly fair to recommend the book for general light scientific reading, but given a natural predisposed interest in the subject, which in itself usually means the right kind of mind for understanding it—why, then it is an excellent book. There is nothing like it available so far as I know, for astrophysics has always been a remote science whose literature postulated a most recondite knowledge of mathematics as the elementary language of its publications.

There are many places in the book where at first sight it seems as if a good deal of cutting or compression could have been carried out, but I am inclined to agree that on second consideration this could not have been wisely done. For, to a layman reading a book of this kind nothing is familiar. He may have an idea of an ordinary laboratory spectroscope, but it is highly improbable that any of the tools of the astrophysicist's trade have even been seen by him. Even more important the *ideas* of the astrophysicist, his currency of thought, all is entirely strange. There were probably moments when Dante, following his guide to the infernal regions, felt that his brain could do with a rest. So too, the reader following Professor Dingle through a physicist's excursion round the universe will feel moments of mental exhaustion. But it is worth it for it is only by slow reading and hard thinking that the picture becomes clear, the reasons plain, and the problems that still confront us fall into the perspective. There are probably a few heresies in the book which another astrophysicist could indicate. But the same is true of all books, and we are not mean enough to argue about trifles (which, by the way, we know nothing about) when a man has made a prodigious effort to render his own vast knowledge of the universe in such a form as to help the layman to some sort of comprehension of it.

*Concerning the Nature of Things.* By SIR WILLIAM BRAGG. K.B.E., D.Sc., F.R.S., Director of the Royal Institution, (Bell & Sons. 7*s.* 6*d.* net).

Clear simple English appears to be one of the gifts which are only granted to our very greatest scientists. It is a paradox that only the extremely first-class brains capable of the most advanced thought can write of scientific matters clearly, coherently and simply so that the ordinary non-scientific mind can follow them. The measure of a writer's style in expounding scientific matters to the lay mind bears a singular relationship to his standing and it is one of the glories of British scientific literature that our leaders of thought have enjoyed the crystal clear vision and the simplicity of style which has enabled them to teach others.

Sir William Bragg's book is founded on his Royal Institution lectures of 1923-24, delivered to a juvenile audience. It is suited to a very much larger audience with no age limit at all, and covers most of the important facts in recent physical discovery.

The first chapter on " The Atoms of which things are made," is undoubtedly the clearest explanation of the modern atomic theory which has yet been written. It owes its lucidity very largely to the fact that Sir William Bragg is wise enough to say the best way of understanding a three-dimensional effect is not to look at a conventional drawing in the flat, but to make a model in the solid. From the sure foundation given by the model it is easy to advance through gases and liquids to the nature of crystals as shown by diamond ice and snow to the more difficult understanding of how atomic structure is the basis of the different qualities of metallic alloys.

We have nothing but praise for this book. There are no gaps in it, no assumptions of learning or even general grasp of facts beyond the compass of the ordinary reader. It is particularly the type of book which appeals to many of those readers of *Discovery* whose knowledge of science was learnt twenty or more years ago, but who wish to keep abreast of modern development made clear to them in simple language.

*Callinicus, a Defence of Chemical Warfare.* By J. B. S. HALDANE. (Kegan Paul. 2*s.* 6*d.* net).

More rubbish has been talked about poison gas than anything else in the war with the sole exception of the myth of Lord Northcliffe's propaganda. It is refreshing to have a book from a sensible cant-free source as an antidote to the loose talk and cloudy thinking of old women of both sexes.

The author is not a militarist, neither is he the popular image of a pacifist. He took part in the war, and his book is exactly the right kind of clear logical thinking that is seldom met with and rarely chronicled in print. No fighting man will deny his good sense and the justice of his conclusions, though there may be professional soldiers who will.

Haldane holds that gas warfare is the least cruel and the most effective of all methods of fighting. He never loses sight of the fact that the main object of warfare is not slaughter but decisive victory, and he has a keen appreciation of the tactical and strategical changes which gas warfare will inevitably bring about in the conduct of future campaigns. It is far better he argues to temporarily disable or immobilize your enemy with an extremely painful affliction which leaves little or no after effects, than to punch holes in him with bits of projectiles which are more lethal and more painful and damage for ever.

There is only one thing to say about this book. Get it and read it. It ought to be adopted as a standard work of instruction at Woolwich and Sandhurst as one of the best books on the lessons of modern warfare.

*More Stories from Birdland.* By OLIVER G. PIKE, F.Z.S., F.R.P.S. (Jarrolds. 6*s.* net).

Mr. Pike is an author who needs no introduction to naturalists and bird lovers, and this little book, despite its title, also introduces two engaging mammals, the squirrel and the dormouse.

The author is a clear-sighted observer and writes simply and unpretentiously of what he has seen. The nature photographer will pick up many hints from his pages and might well tempt the modern serious student of zoology to abandon the charms of a dissection in favour of a little open-air observation work. Distinctly a good little book for children.